11-1520-221-34

TM 11-1520-221-34

TECHNICAL MANUAL

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

ELECTRONIC EQUIPMENT CONFIGURATIONS ARMY MODELS AH-1G, AH-1Q, AND AH-1S(MOD) HELICOPTERS

This copy is a reprint which includes current pages from Changes 1 through 3. The title was changed by C 3 to read as shown above.

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No. TM 11-1520-221-34

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., *25 September 1971*

Direct Support and General Support Maintenance Manual

ELECTRONIC EQUIPMENT CONFIGURATIONS

ARMY MODEL AH-1G AND AH-1Q HELICOPTERS

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WARNING

DANGEROUS VOLTAGES EXIST IN THESE CONFIGURATIONS

Be careful when working on the 115-volt ac output circuits of the inverters.

DEATH ON CONTACT MAY RESULT IF SAFETY PRECAUTIONS ARE NOT OBSERVED

Be careful not to come in contact with or close proximity to high-voltage connections or any power connections when using this equipment. Turn off the power and discharge all high-voltage capacitors before making any connections or doing any work inside the equipment. Voltages as high as 1,500 volts dc are present in these configurations.

RF BURNS

Do not touch or stand too close to radiating antennas. Serious RF burns may result. Move away from antenna or transmitting equipment if any part of the body area feels flushed.

DANGEROUS CHEMICALS ARE USED IN NICKEL-CADMIUM BATTERIES

The electrolyte used in nickel-cadmium batteries contains potassium hydroxide (KOH), which is a caustic agent. Serious and deep burns of body tissue will result if the electrolyte comes in contact with the eyes or any part of the body. Use rubber gloves, rubber apron, and protective goggles when handling the electrolyte. If accidental contact with the electrolyte is made, use ONLY clean water and immediately (seconds count) flush contaminated areas. Continue flushing with large quantities of clean water for at least 15 minutes. Seek medical attention without delay.

DO NOT TAKE CHANCES!

CHAPTER 1

INTRODUCTION

1-1. Scope

a. This manual covers direct and general support of the electronic equipment configuration for Army Model AH-1G, and AH-1Q Helicopters, Serial Numbers 66-15249 through 66-15357, 67-15450 through 67-15869, 68-15000 through 68-15213, 68-17020 through 68-17113, 69-16410 through 69-16447, 70-15936 through 70-16105; and helicopters that have been retrofitted in accordance with MWO's 55-1520-221-20/5, 55-1520-221-20/7, 55-1520-221-20/9, 55-1520-221-30/1, 55-1520-221-30/12, 55-1520-221-30/13, 55-1520-221-30/17, 55-1520-221-30/26, and 55-1520-221-30/36. It includes instructions appropriate to direct support maintenance personnel for troubleshooting electronic equipment when the equipment is installed in the helicopter. This manual lists tools, test equipments, and materials required by direct support maintenance personnel to maintain the helicopter electronic equipment configuration. Also included in this manual are complete direct and general support instructions with appropriate lists of tools, test equipments, and materials required for performing bench or shop maintenance of certain electronic equipment components.

b. Bench maintenance of many of the electronic equipment configuration components is covered in other technical manuals. The pertinent technical manuals for these electronic equipments are listed in appendix A. When servicing these electronic equipments, refer to those manuals for detailed troubleshooting, testing, aligning, and repair procedures, and for replacing or repairing maintenance parts.

c. Block diagram analysis of the entire electronic equipment configuration and the individual facilities that are contained in the electronic equipment configuration is covered in TM 11-1520-221-20. Analysis of the electronic configuration interunit circuits is covered in paragraphs 2-3 through 2-14 of this manual. Block diagrams and detailed circuit analyses of electronic equipment components that do not have separate manuals are covered in section II, chapter 2, and chapter 5 of this manual. For electronic equipments covered by separate technical manuals, refer to appendix A for pertinent manuals regarding the block diagrams and detailed circuit analyses.

d. The addition of an asterisk inclosed in parentheses to the official nomenclature is used to indicate all models of the equipment discussed in this manual. TM 11-1520-221-20 lists the equipment to which this symbol will apply.

e. The reporting of errors, omissions and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded to Commander, US Army Electronics Command, ATTN: DRSEL-MA-Q, Fort Monmouth, NJ 07703.

NOTE

For applicable forms and records, see TM 11-1520-221-20.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to the latest issue of DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. Reference Designations and Equipment Identification

a. General. The electronic equipment components illustrated in this manual are grouped by the facility and the configuration they are associated with, and are identified by part number or official nomenclature. The subassemblies and parts of these equipments are identified by reference designations. Reference designations consist of groups of letters and numbers that identify the subassemblies and parts. Some of the subassemblies and parts within the electronic equipments have reference designations assigned to items according to the unit numbering system, and some equipments use the block numbering system. For the reference designation system and the grouping of items within a particular electronic equipment, refer to appendix A for the applicable technical manual covering the equipment.

b. Electronic Configuration. The facilities in the configuration covered by this manual, and the model and serial numbers of the helicopters included in the configuration are in the chart below. For detailed electronic equipment breakdown of each facility, with its associated configurations, helicopter models, and serial numbers, refer to TM 11-1520-221-20.

NOTE

The electronic configuration in the AH-1Q, designated as configuration F, is the same as in configurations A, B, C, D, and E except for location of components, and the main inverter. All other components, wire numbers, etc. are the same. Refer to TM 11-1520-221-20 for specific equipment relocation.

Facility	*Equipment*
Interphone and audio	Control, Intercommunication Set C-1611/AIC
Fm liaison	Radio Set AN/ARC-54 or AN/ARC-131
Uhf command	Radio Set AN/ARC-51BX
Automatic direction finding (Adf) system	Direction Finder Set AN/ARN-83
Gyromagnetic compass	Gyromagnetic Compass System AN/ASN-43
Iff system	Transponder Set AN/APX-44 or AN/APX-72
Vhf command	Radio Set AN/ARC-134
Stability and control augmentation system (SCAS)	SCAS, Model 570A
Dc source	Battery BB-433/A or BB-649/A

Facility	*Equipment*
Ac source (Main inverter) (A through E configuration)	Motor Generator PU-542 (A)/A or PU-542(*)/A
Ac source (Main inverter) (F configuration)	Inverter, Power 209-075-572
Standby ac source (standby inverter)	Inverter, Power, Static PP-6508/U

Configuration	*Helicopter Serial No.*
A	66-15249 – 66-15257
B	66-15258 – 66-15357
C	67-15450 – 67-15869
D	68-15000 – 68-15213
	68-17020 – 68-17113
	68-16410 – 69-16447
E	70-15936 – 70-16105
F	AH-1Q

CHAPTER 2

INTERUNIT CIRCUIT ANALYSIS AND OPERATION

Section I. INTRODUCTION TO FUNCTIONING DISCUSSIONS

2-1. Introduction

The purpose, operation, and interoperation of the various circuits in electronic equipment configuration and in the individual electronic equipments used in the electronic equipment configuration are explained in this chapter and also in the technical manuals covering certain electronic equipments of each electronic equipment configuration. This chapter is divided into four sections. Section I covers introduction and main power application. Section II contains detailed circuit analysis of configuration. Familiarity with the electronic equipment configurations and the individual electronic equipments, how they work and why they work that way, is important in troubleshooting the electronic equipment configurations and the individual electronic equipments rapidly and effectively.

2-2. Main Power Application

Dc power is applied by an engine-driven generator or by the helicopter battery, or by an externally applied auxiliary power unit which is connected to the helicopter through the external power connector. Refer to TM 11-1520-221-20 for auxiliary power connection.

a During normal in-flight operation, +28 volts dc is supplied to the dc bus from the engine-driven generator through a reverse current relay. The generator operates when the helicopter engine is running. The generator supplies +28 volts to the dc bus when the GEN control switch on the instrument pedestal is at ON.

b. The helicopter battery is used for emergency purposes if the engine-driven generator becomes inoperative while the helicopter is in flight. The battery supplies power to the dc bus when the BAT (battery) switch on the instrument pedestal is at ON.

c. When the helicopter is on the ground, an external power unit is connected to the helicopter through the external power connector for use in starting the helicopter and for testing and troubleshooting of signal equipment in the helicopter. The BAT(battery) switch must always be at OFF before connecting an external power unit to the external power connector.

Section II. ANALYSIS AND OPERATION

2-3. Primary Power

Low voltage for communication, navigation, identification, stability, and interphone facilities is supplied from an auxiliary power unit, through the external power receptacle and external power relay, to the helicopter's +28-volt dc bus in the instrument panel or from the helicopter's battery through the BAT switch and the battery relay to the dc bus. High voltage used in the operation of the radio equipment is supplied by power components of the radio sets. The radio sets are connected to the +28-volt dc bus through individual circuit breakers on the instrument panel. Distribution of primary power for the interphone facility, communication facilities, and navigation facilities are covered in *a* through *i* below.

a. Interphone and audio Facility (Control, Intercommunication, Set C-1611/AIC) Primary Power (fig. FO-2, FO-3, FO-4 and FO-4.1). Interphone communication is accomplished through the Control, Intercommunication Set C-1611(*)/AIC at the pilot's and gunner's positions. To obtain amplification of the interphone audio signals, power must be applied to the amplifier circuits in the C-1611(*)/AIC. Operating voltage for the C-1611(*)/AIC is furnished to the power relay in each C-1611(*) AIC by the helicopter 28-volt dc bus through the ICS circuit breaker (through pins 37 of connectors P301A and P301F).

b. Fm Liaison Facility (Radio Set AN/ARC-54) Primary Power (fig. FO-5). With the FM

XCVR-54 circuit breaker button depressed, power for the Receiver-Transmitter, Radio RT-348/ARC-54 is applied through the PTT-RET-HOME switch S101-C on the Control, Radio Set C-3835/ARC-54. When the PTT-RET-HOME switch on the C-3835/ARC-54 in the PTT position, +28 volts dc is applied to receiving and transmitting circuits of the RT-348/ARC-54 from the dc circuit breaker panel to pins E and C of connector J2107 on the C-3835/ARC-54 through the closed PTT-RET-HOME switch to terminals 34 and 36 of connector J2106 of RT-348/ARC-54.

c. Uhf Command Facility (Radio Set AN/ARC-51BX) Primary Power (fig. FO-6 and FO-6.1). With the UHF XCVR circuit breaker button depressed, +28 vdc is applied to pins A and B of P1403/J1403. The RT-742/ARC-51BX receives its primary voltage when the function selector switch on the C6287/ARC-51BX is moved to any position other than OFF. This is accomplished by ground being applied from pin A of J3801 to pin T of J1403 to an internal power relay in the RT-742/ARC-51BX. A +28 vdc is present on the contacts of this relay through pins A and B of J1403 whenever the UHF circuit breaker is depressed.

d. Vhc Command Facility (Radio Set AN/ARC-134) Primary Power (fig. FO-7, FO-8 and FO-8.1). With the VHF XCVR circuit breaker depressed, power for the Receiver-Transmitter, Radio AN/ARC-134 is applied through the power switch on the Control, Radio Set C-7197/ARC-134. When the power switch on the C-7197/ARC-134 is in the PWR position, power relay K2001 in the RT-857/ARC-134 is energized, 28 vdc from the circuit breaker is applied to pins 3 and 4 of J1904A of the RT-857/ARC-134.

e. Adf Navigation Facility (Direction Finder Set AN/ARN-83) Primary Power (fig. FO-9) With the ADF circuit breaker depressed, power for the Receiver R-1391/ARN-83 is applied through the function switch on the Control, Direction Finder C-6899/ARN-88. With the function switch in ADF position, +28 volts dc is applied to receiving circuits of the R-1391/ARN-83 from the dc circuit breaker panel through 2 pins K and L of J302 on the C-6899/ARN-83 to pin 26 of J407 on the R1391/ARN-83.

f. Gyromagnetic Compass Facility (Directional Gyro CN-998/ASN-43). Primary Power (fig. FO-10). With the GYRO COMP circuit breaker depressed, power for the compass facility is applied from the ac circuit breaker panel to pin C of J411 on the CN-998/ASN-43 and pin 7 of P415 on the Amplifier, Electronic Control AM-3209/ASN.

g. Iff Facility (Transponder Set AN/APX-44) Primary Power (fig. FO-11 and FO-12). With the Iff circuit breaker depressed, power for the Receiver-Transmitter, Radar RT-494/APX-44 is applied through the master control switch on the Control, Transponder Set C-2714/APX-44. With the master control switch in STBY position, +28 volts dc is applied to receiving and transmitting circuits of the RT-494/APX-44 through the master control switch on the C-2714/APX-44 to pin 2 of J906 to pin 44 of J902.

h. Iff Facility (Transponder Set AN/APX-72) Primary Power (fig. FO-11, FO-12, FO-12.1 and FO-12.2). With the Iff circuit breaker depressed, power for the Receiver-Transmitter, Radar RT-859/APX-72 is applied through the master control switch on the Control, Transponder Set C-6280/APX-72. With the master control switch in STBY position, +28 volts dc is applied to receiving and transmitting circuits of the RT-859/APX-72 through the master control swtich on the C-6280/APX-72 to pin 2 of J906.

i. Homing Facility (Lead Foil Antenna) Primary Power (fig. FO-5). With the FM XCVR circuit breaker on the instrument pedestal depressed, power is applied to HOME portion of selector switch S101 on Control, Radio Set C-3835/ARC-54. Power from pin DD of connector P-2107 on the C-3835/ARC-54 is applied to the homing module of the Receiver-Transmitter RT-348/ARC-54 through pin 16 on P2106. For details on the AN/ARC-54 homing operation refer to the technical manual for Radio Set AN/ARC-54.

2-4. Interphone and Audio Signal Distribution

(fig. FO-2, FO-3, FO-4 and FO-4.1)

a. Audio Signals. Audio signals originating at either pilot's or gunner's Headset-Microphone H-101/U are preamplified in the associated Control, Intercommunication Sets C-1611(*)/AIC. The position of the transmit-interphone selector switch on the C-1611(*)/AIC will determine the distribution of the audio signals. In the INT position, the audio signals from the associated H-101/U are coupled through one C-1611(*)/AIC to the other C-1611(*)/AIC for interphone communication. In position 1, the audio signals from the C-1611(*)/AIC panels are

coupled to the transmitter section of the Receiver-Transmitter RT-348/ARC-54 for transmission. In position 2, the audio signals from the C-1611(*)/AIC panels are coupled through the MD-736 discrete signal discriminators to the transmitter section of the Receiver-Transmitter, Radio RT-742/ARC-51BX for transmission. In position 3, the audio signals from the C-1611(*)/AIC panels are coupled through the MD-736 discrete signal discriminators to the Receiver-Transmitter RT-857/ARC-134 for transmission. The C-1611(*)/AIC panels also contain headset amplifiers for the amplification of all signals to be received in the H-101/U headsets, including the sidetone signals from the associated H-101/U microphones. For private interphone communication, TRANS switch is set to PVT, and RECEIVERS switch is set to INT (up) position. Primary power for operation of the interphone facility is provided by the ICS C-1611 circuit breaker on the instrument pedestal.

b. Interphone.

(1) *Press-to-talk control.*

(*a*) For interphone communication with the C-1611/AIC, the TRANS selector switch on the C-1611/AIC is set to INT. When the pilot's or gunner's cyclic switch is pushed to ICS (down), the return to ground is made through pin 14 of J301F or J301A through interphone relay, which causes the relay to energize and thus actuate microphone amplifier A4.

(*b*) When the HOT MIKE switch at one C-1611/AIC is actuated to ON (steady) or MC (momentarily closed), or when ground crew headset microphone line switch is closed, ground for pins 16 and 17 of J301A or J301F is made to pin 6 of J600 of impedance matching assembly to complete groundpath. Completing ground energizes K1 interphone relay in C-1611 AIC and keeps all microphones hot.

(2) *Transmit-receive control.* When the gunner's footswitch is closed or when cyclic stick switch is pushed to radio (up), a ground path is completed from pin H on P91 to pin 5 of J600, out on pin 7 of J600 to pin 15 of P301F. When the pilot's cyclic stick switch is pressed to radio (up) position, a ground path is completed from pin H of P34 through pin 4 of J600 and out on pin 11 of J600 to pin 15 of P301A.

2-5. Audio Signal Distribution

NOTE

Refer to FO-2 (configurations A and B), FO-3 (configuration C), FO-4 (configuration D) and FO-4.1 (configuration E).

Audio signals originating at a Headset-Microphone H-101/U are distributed through the communication impedance matching network P/N 209-075-235 (fig. 2-1, 2-2 and 2-2.1) and the Control, Intercommunication Set C-1611(*)/AIC for interphone communication or for transmission and reception by the Radio Set AN/ARC-54 or Radio Set AN/ARC-51BX or the Radio Set AN/ARC-134. The mode of operation is controlled by the transmit-interphone selector switch on the C-1611(*)/AIC panel. When in use, the C-1611(*)/AIC may be operated in any one of four modes, as determined by the settings of the transmitter-interphone selector switch and the RECEIVERS switches S1 through S7 in the control circuits. The three modes of operation used are two-way (air-to-air and air-to-ground) radio communication, radio receiver monitoring, and intercommunication (interphone and private interphone) between pilot and gunner.

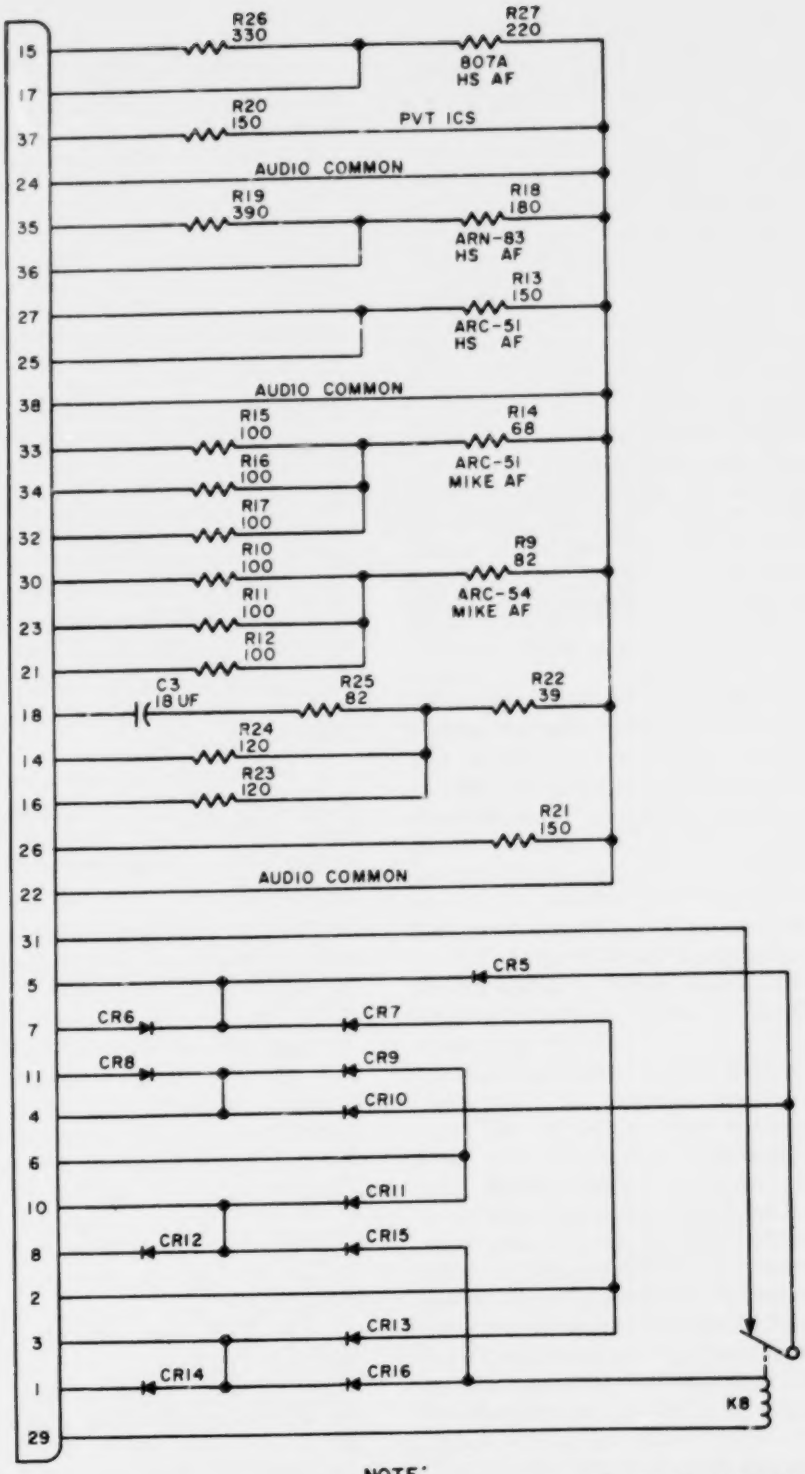
a. Energizing Circuits. Low voltage (+28 volts dc) for the pilot's and gunner's distribution panels is supplied from the ICS C-1611 circuit breaker panel to pin 37 of J301 of each distribution panel.

b. Pilot's Transmission Circuits. Audio signals originating at the microphone portion of the pilot's H-101/U are coupled through terminal board TB22 through terminals 3 (high) and 22 (low) of the pilot's C-1611(*)/AIC.

(1) If the pilot and gunner of the aircraft want to intercommunicate, they do so by moving the transmitter phone selector switch to INT or PVT for private uninterrupted conversation. Through this arrangement the microphone output signaled by a member's voice is passed through microphone preamplifier, microphone amplifier, and control circuits of headset amplifier to the interphone or private interphone line. The signal portion applied to headset amplifier is received by the earphone as sidetone. The amplified signal is applied to the interphone line and is received by other stations connected to the same line (PVT).

(2) With the transmit-interphone selector switch in position 1, audio signals are fed from terminal 24 of the pilot's C-1611(*)/AIC, through the impedance matching assembly and through the C-3835/ARC-54 to the Receiver-Transmitter, Radio RT-348/ARC-54 for transmission.

(3) With the transmit-interphone selector switch on the C-1611(*)/AIC in position 2, audio signals are fed from terminal 25 of the pilot's C-1611(*)/AIC, through the communication im-



NOTE:
RESISTANCE IN OHMS

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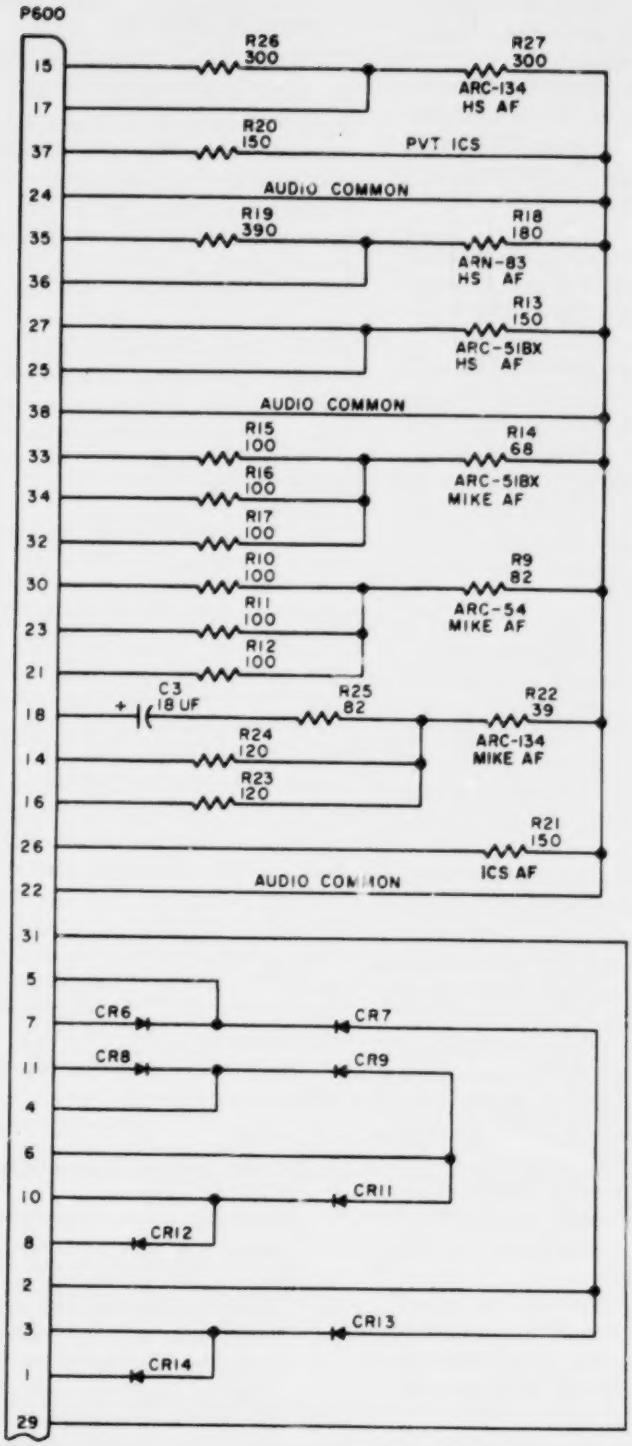
Figure 2-1. Impedance matching network schematic, configurations A, B, and C.



NOTE:
RESISTANCE IN OHMS

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Figure 2-2. Impedance matching network schematic, configuration D.

pedance matching assembly, to the C-6287/ARC-51BX, then to the Receiver-Transmitter, Radio RT-742/ARC-51BX for transmission.

(4) With the transmit-interphone selector switch on the C-1611(*)/AIC panel in position 3, audio signals are fed from terminal 26 of the pilot's C-1611(*)/AIC, through the communication impedance matching assembly to AN/ARC-134.

c. Pilot's Receiving Circuits. All audio signals from the receivers are routed to the headset portion of the H-101/U through the C-1611(*)/AIC panel.

(1) Audio signals from the AN/ARC-54 are routed through J2107 pin N to pin 30 of J301A of the pilot's C-1611(*)/AIC. The signals are routed through the transmit-interphone selector switch (position 1) or RECEIVERS 1 switch to audio output pins 5 and 23 of J301A of the pilot's C-1611(*)/AIC, through terminal board TB23 and to the headset portion of the pilot's H-101/U.

(2) Audio signals from the AN/ARC-51BX are routed through J600 pin 31 or J301 of the pilot's C-1611(*)/AIC. The audio signals are then routed through the transmit-interphone selector switch (position 2) or RECEIVERS 2 switch to audio output pins 5 and 23 of J301 of the C-1611(*)/AIC, through terminal board TB23 and to the headset portion of the pilot's H-101/U.

(3) Audio from AN/ARC-134 is routed into pin 32 of J301A of the pilot's C-1611(*)/AIC. The signals are routed through the transmit-interphone selector switch (position 3) of RECEIVERS 3 switch to audio output pins 5 and 23 of J301A of the pilot's C-1611(*)/AIC, through terminal board TB23 and to the headset portion of the pilot's H-101/U.

d Gunner's Transmission and Receiving Circuits. The gunner's transmission and receiving circuits are similar to those of the pilot. Audio signals from and to the gunner's position are distributed through the gunner's C-1611(*)/AIC in the same manner as described for the pilot's operation *b* and *c* above).

e. Emergency Operation. There is no emergency operation provision because all transmitted and received audio signals pass directly through the C-1611(*)/AIC panels with controls set for selected signals.

2-6. Interphone Communication Operation

NOTE

Refer to FO-2 (configurations A and B), FO-3 (configuration C), FO-4 configuration D) and FO-4.1 (configuration E).

a. General. Interphone communication between the pilot and gunner is accomplished through the C-1611(*)/AIC. Signals originating at the microphone portion of a headset microphone are amplified by the associated C-1611(*)/AIC. Microphone signals from the pilot are routed through the pilot's C-1611(*)/AIC and through the gunner's C-1611(*)/AIC to the headset portions of the H-101/U headsets. Microphone signals from gunner are routed through the gunner's C-1611(*)/AIC and through the pilot's C-1611(*)/AIC to the pilot's H-101/U. Audio impedance matching is provided by the resistor and capacitor network system (fig. 2-1, 2-2 and 2-2.1) mounted on the impedance matching assembly (fig. 2-3).

b. Interphone Communication. Audio signals for communication are amplified by the C-1611(*)/AIC panels. Dc power for operation of the interphone facility is furnished by the +28V DC bus through the ICS circuit breaker. The pilot and gunner can carry on interphone communications by depressing the microphone switch on the cyclic control grip. One-way communication is established from the pilot or the gunner when either operates the transmit-interphone selector switch on his C-1611(*)/AIC to INT. Microphone signals flow to pin 3 of J301 of distribution panel, through microphone preamplifier and amplifier and through trans-selector switch to pin 8 of J301. The amplified signal output from pilot's C-1611(*)/AIC is connected to the gunner's H-101/U headset through the gunner's C-1611(*)/AIC. The amplified signal output from the gunner's C-1611(*)/AIC panel is connected to the pilot's H-101/U through the pilot's C-1611(*)/AIC.

2-7. Fm Liaison Communication (fig. FO-5)

NOTE

Radio Set AN/ARC-131 may be installed in lieu of Radio Set AN/ARC-54. In the following steps, references to Radio Set AN/ARC-54 also apply to Radio Set AN/ARC-131.

a. General. Radio Set AN/ARC-54 (fig. FO-5) provides fm communication facilities for liaison operation. The AN/ARC-54 also provides for homing facilities by use of the lead foil antenna.

(1) Operating voltage is applied to the re-

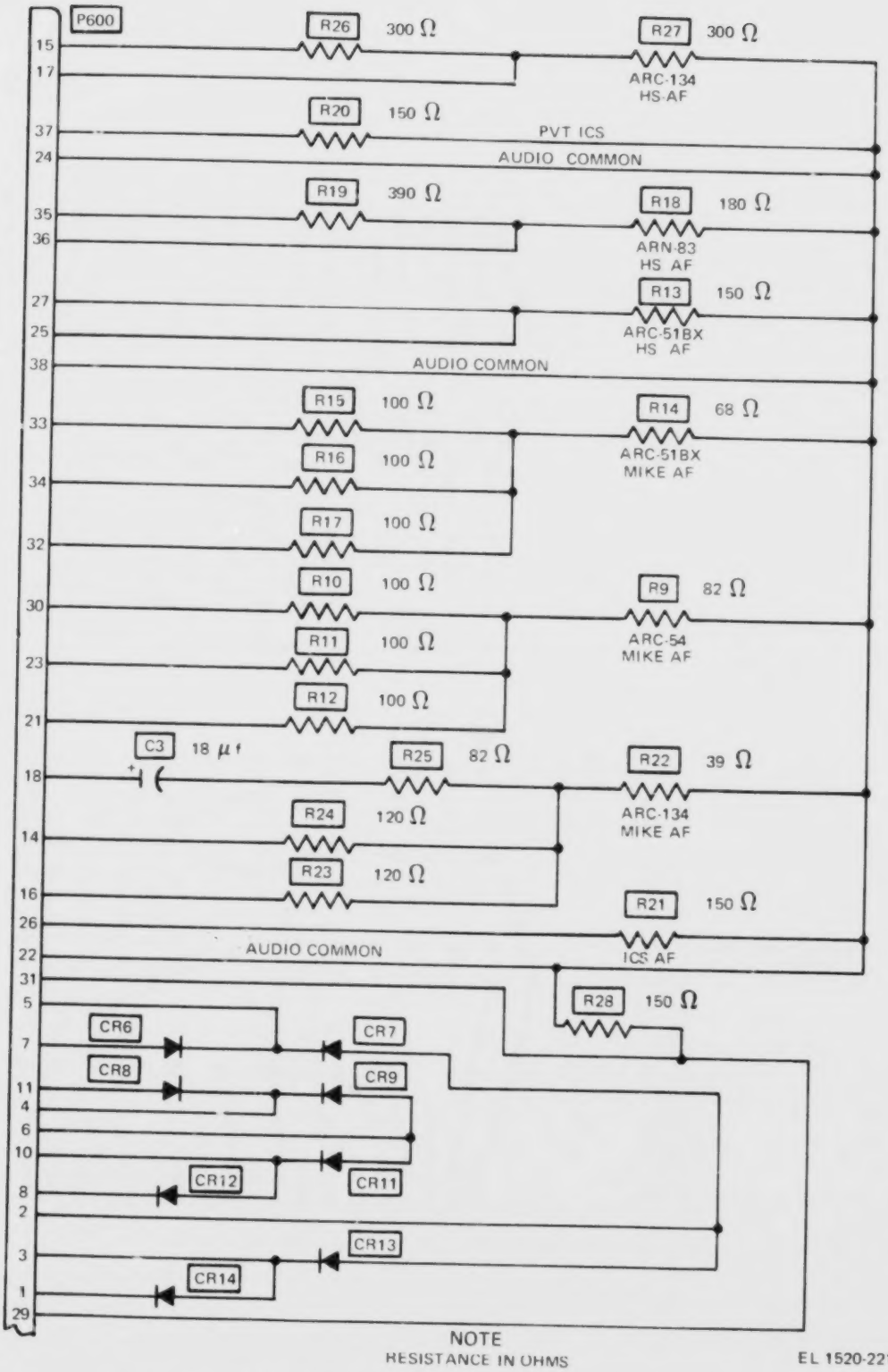
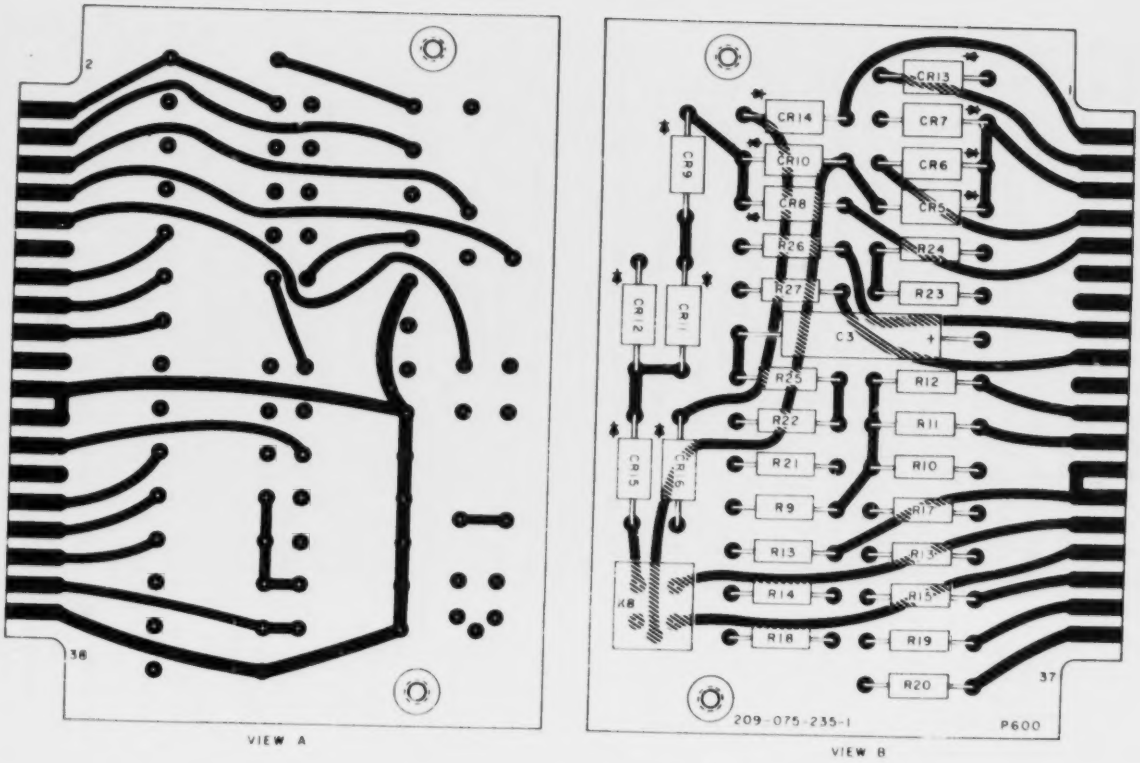
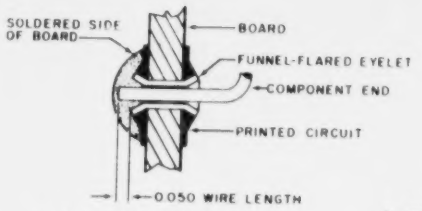


Figure 2-2.1 Impedance matching network schematic, configuration E.



REF DESIG	PART NUMBER	DESCRIPTION
C3	CL25BJ180UP3	CAPACITOR
CR5	IN2071	DIODE
CR6		
CR7		
CR8		
CR9		
CR10		
CR11		
CR12		
CR13		
CR14		
CR15		
CR16	IN2071	DIODE
K8	C2A-126	RELAY
R9	RC20GF820J	RESISTOR
R10	RC20GF101J	RESISTOR

REF DESIG	PART NUMBER	DESCRIPTION
R11	RC20GF101J	RESISTOR
R12	101J	
R13	151J	
R14	680J	
R15	101J	
R16	101J	
R17	101J	
R18	181J	
R19	391J	
R20	151J	
R21	151J	
R22	390J	
R23	121J	
R24	121J	
R25	820J	
R26	331J	
R27	RC20GF221J	RESISTOR



NOTES

1. SOLDER COMPONENTS ON ONE SIDE OF BOARD ONLY AS SHOWN IN DETAIL OF CONNECTION.
2. AFTER REPLACEMENT OF ANY PART, SPRAY TWO COATS OF VARNISH ON AREA WORKED BUT DO NOT SPRAY AREA OF CONTACTS.

EL1520-221-35-TM-14

Figure 2-3. Impedance matching network circuit board. Configuration A, B, C, and D

ceiver circuits in the Receiver-Transmitter, Radio RT-348/ARC-54, through the depressed FM XCVR circuit breaker. For complete fm set communication operation the ICS C-1611 circuit breaker must also be depressed. The RT-348/ARC-54 will be in the receive condition until the microphone switch on either cyclic control grip is depressed to RADIO position or until gunner's SA-47A/AIC footswitch is depressed. When the pilot or gunner depresses his microphone switch to position RADIO or when the gunner actuates his SA-47A/AIC with C-1611 (*)/AIC TRANS selector switch set to 1, a full 500 volts dc is applied to the power amplifier tube plate and 250 volts dc is applied to the screen grids, and the RT-348/ARC-54 is in the transmit condition.

(2) Signals from the microphone of either the pilot or gunner station are routed through the C-1611(*)/AIC panels to RT-348/ARC-54. Preamplification of the audio signals occurs in the C-1611(*)/AIC panels. The output frequency of the transmitter section is controlled by Control, Radio Set C-3835/ARC-54. The output of the transmitter section is coupled to the fm antenna type 437S-1 for propagation.

(3) Signals received by the fm antenna type 437S-1 are coupled to the receiver section of the RT-348/ARC-54. The RF signals are demodulated and amplified in the receiver sections. The resulting audio output frequency of the receiver section is coupled to each C-1611(*)/AIC through the C-3835/ARC-54. The audio output from the pilot's C-1611(*)/AIC is coupled to the pilot's H-101/U. The audio output from the gunner's C-1611(*)/AIC is coupled to his H-101/U.

b. Transmission Signal Flow.

(1) *General.* Positive 28 volts dc is applied to the AN/ARC-54 fm liaison set (fig. FO-5) through the FM ARC-54 circuit breaker, and to the C-1611(*)/AIC panel through the ICS C-1611 circuit breaker. Operating power is applied to the C-1611(*)/AIC panels and to all the circuits in the RT-348/ARC-54 except the RF power amplifier in the transmitter section. When the microphone switch on either cyclic control grip is depressed to position RADIO or when gunner's foot switch is actuated, voltages are applied to the transmitter section, enabling the transmitter to operate.

(2) *Pilot's transmission circuit.*

(*a*) With the transmit-interphone selector switch on the pilot's C-1611-(*)/AIC set to position 1 and the microphone switch on the pilot's cyclic grip depressed to RADIO position, or with the gunner's SA-47A/AIC foot switch actuated, a ground is placed on the low side of the RF power amplifier; this section activates the coils in the module of the RT-348/ARC-54 for transmitter operation.

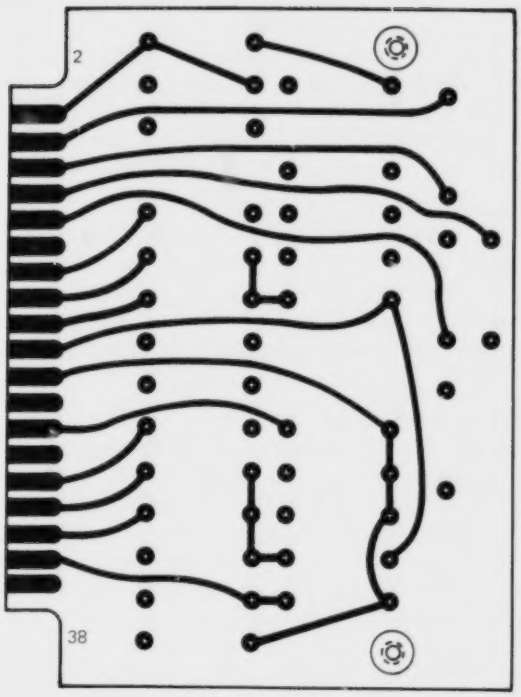
(*b*) When the pilot speaks into the microphone, the audio signals are coupled to pins 3 and 22 of J301A of C-1611(*)/AIC, through microphone preamplifier and amplifier and through transmit-interphone selector switch to pin 24 of J301A and then to J2107 of C-3835/ARC-54. From the C-3835/ARC-54 it is applied to pin 6 of P2106 on the RT-348/ARC-54 and then to the transmit audio module within the RT-348/ARC-54. The RF power amplifier is now modulated, and the frequency-modulated RF signal is coupled from P2105 to the fm antenna type 437S-1 for propagation. The gunner may listen to the transmitted signal from the pilot by operating the RECEIVERS 1 switch on his C-1611(*)/AIC to the gunner's position.

(3) *Transmission circuit.*

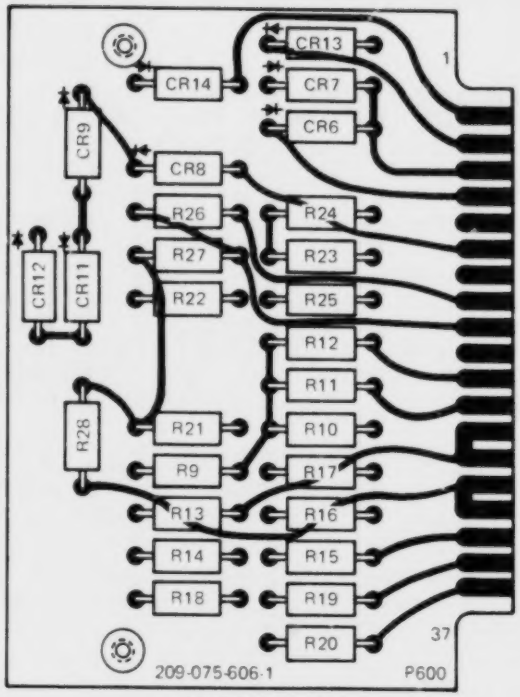
(*a*) With the transmit-interphone selector switch on the gunner's C-1611(*)/AIC operated to position 1 and the gunner's cyclic control grip microphone switch pushed to RADIO position, or with gunner's SA-47A/AIC footswitch actuated, RT-348/ARC-54 operation is set up as described in (2)(*a*) above.

(*b*) When the gunner speaks into the microphone, the audio signals are coupled to pins 3 and 22 of J301F of C-1611(*)/AIC, through microphone preamplifier and amplifier, and through transmit-interphone selector switch pin 24 of J301F. The signal progresses in the same manner as described in (2)(*b*) above.

c Reception Signal Flow. Incoming RF signals received by the fm antenna type 437S-1 are amplified and demodulated in the receiver portion of the RT-348/ARC-54. The resulting audio signal is transferred to C-3835/ARC-54 connector J2107 pin JJ. It goes through R101 volume control and departs from J2107 on pin N. It is then transferred to the pilot's and gunner's C-1611(*)/AIC control panels, where it is amplified in the headset amplifiers. From pins 5 and 23 of J301 (Gunners and Pilots distribution panels), it is fed through TB22 and TB23 to H-101/U headsets (Gunner's and Pilot's respectively). The AN/ARC-54 uses BHC leadfoil antenna homing operation.



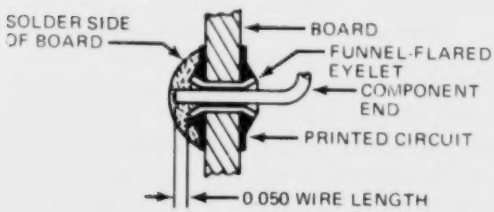
SOLDER SIDE



COMPONENT SIDE

REF DESIG	PART NUMBER	DESCRIPTION
CR6	IN2071	DIODE
CR7		
CR8		
CR9		
CR11		
CR12		
CR13		
CR14	IN2071	DIODE
R9	RC20GF820J	RESISTOR
R10	101J	
R11	101J	
R12	101J	
R13	151J	
R14	RC20GF680J	RESISTOR

REF DESIG	PART NUMBER	DESCRIPTION
R15	RC20GF101J	RESISTOR
R16	101J	
R17	101J	
R18	181J	
R19	391J	
R20	151J	
R21	151J	
R22	390J	
R23	101J	
R24	101J	
R25	101J	
R26	301J	
R27	301J	
R2P	RC20GF151J	RESISTOR



DETAIL OF CONNECTION

NOTES

1. SOLDER COMPONENTS ON ONE SIDE OF BOARD ONLY AS SHOWN IN DETAIL OF CONNECTION.
2. AFTER REPLACEMENT OF ANY PART, SPRAY TWO COATS OF VARNISH ON AREA WORKED BUT DO NOT SPRAY AREA OF CONTACTS.

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Figure 2-3.1 Impedance matching network circuit board, configuration E.

2-8. FM Homing Operation

NOTE

Radio Set AN ARC-131 may be installed in lieu of Radio Set AN/ARC-54. In the following steps, references to Radio Set AN ARC-54 also apply to Radio Set AN/ARC-131.

a. General. The homing mode of operating is selected with the mode control switch on the C-3835/ARC-54 set to HOME position. This applies the necessary grounds and voltages to the homing circuits in the RT-348/ARC-54. Homing mode is available throughout the entire frequency range of the AN/ARC-54.

b. Operation. When homing mode is selected, a homing switch is energized in the RT-348/ARC-54. The switch alternately samples left and right inputs from the homing antenna at a 100-Hz rate. The composite signal is amplified through the normal RF path in the RT-348/ARC-54 and routed to the mechanical chopper K201. The output of the chopper feeds the homing indicator needle, causing deflection anytime the aircraft is not headed toward the transmitting station. The squelch circuits control the flag arm which in turn provides a visual indication of signal strength.

2-9. Uhf Command Operation (fig. FO-6 and FO-6.1)

a. Power Distribution.

(1) *Receiver circuits.* With UHF XCVR circuit breaker depressed and with selector switch on the uhf control panel set to T/R+G REC, the dc circuit for power relay coil in uhf receiver-transmitter is completed to ground. The energized power relay applies primary operating voltage through closed contacts to receiver-transmitter circuits, placing the facility in receive mode.

(2) *Transmitter circuits.* High voltage dc for receiver-transmitter is applied through closed contacts of internal tr relay, placing receiver-transmitter in transmit mode. When the Cyclic stick switch ICS/RADIO is pressed to RADIO position or when the gunner's footswitch is depressed, dc voltage is applied to tr relay coil through closed contacts of the power relay. The dc circuit for tr relay is completed to ground through the deenergized contacts of disable relay, through pin P of P1403 of RT-742/ARC-51BX to pin q of J3802 to pin 34 of C-1611(*)/AIC. Audio disable relay is energized during tuning cycle and prevents keying of transmitter during the tuning cycle.

b. Audio Distribution.

(1) *Audio reception.* Audio signals from the AN/ARC-51BX facility (fig. FO-6 and FO-6.1 are routed from pin E of J3801 on Control, Radio Set C-6287/ARC-51BX through the C-1611(*)/AIC out pin F of P3801, to pin 27 of J600 of impedance matching assembly, to pin 22 of P600, to terminal 4 of TB21, to pin 19 of both C-1611/AIC panels. The audio signal is routed through the C-1611(*)/AIC, out on pin 5 of J301F of the gunner's C-1611/AIC and J301A of the pilot C-1611(*)AIC, to J308 and J309 respectively, and to headsets of the headset-microphones.

(2) *Audio transmission* When the pilot or gunner set their TRANS selector switch on C-1611(*) AIC panel in position 2, and with a cyclic stick switch pressed to RADIO position or with the gunner's foot switch depressed, audio signals are fed from headset-microphone to pins 3 and 22 of J301A on the C-1611(*)/AIC out pin 24, 25, or 26 of J301 of C-1611(*)/AIC to pin 34 of J600 of impedance matching assembly, out on pin 38, of P600 to pin i on P3802, to pin i on J3802, to pin E on P1403 of Receiver-Transmitter, Radio RT-472/ARC-51BX. The signal is modulated RT-742/ARC-51BX and transmitted through the AT-1108/ARC antenna.

2-10. Automatic Direction Finding (Adf) Operation (fig FO-9)

a. Power Distribution. Depressing the ADF circuit breaker on the pilot's ac circuit breaker panel applies 26 volts ac to pin J of Direction Finder Control C-6899/ARN-83 and pin 8 of Mounting MT-3605/ARN-83. The dc circuit breaker applies 28 volts dc to pin K of the C-6899/ARN-83. Setting function switch to ADF position completes a path to pin 26 of P407 on Radio Receiver R-1391/ARN-83 through pin 36 to ground.

b. Signal Distribution. RF voltage received by the sense antenna, the loop antenna or both, depending on mode of operation, are demodulated by the R-1391/ARN-83. Audio is fed to the C-6899/ARN-83 through pins 23 and 24 of P407 and pins T and U of J302. Controlled audio is routed from the control on pins W and V of J302 to pins 24 and 35 of P600, the impedance matching assembly. From here, the signal enters the C-1611(*)/AIC through the NAV RC-

VRS switch is amplified and fed to the headsets. Bearing data voltages are fed through P407 on pins 19 and 20 to the indicators.

2-11. Gyromagnetic Compass System Operation
(fig. FO-10)

a. Power Distribution. Depressing the GYRO COMPS IND circuit breaker applies 115 volts ac, 400 Hz, to the Directional Gyro CN-998/ASN on pins A and C, and to Amplifier Electronic Control AM-3209/ASN on pins 7 and 12. Applying 115 volts, 400 Hz, to the AM-3209/ASN activates an inventer circuit that provides 26 volts ac to the Indicator, Radio-Magnetic Compass ID-998/ASN for generator excitation.

b. DG Mode. Directional gyro (DG) mode of operation is selected by setting compass slaving switch, located on pilot's instrument panel to DG position. In the DG mode, a stable reference is provided by the heading and slaving synchros, which are driven by the gyro motor. The heading synchro rotor and slaving synchro rotor are mechanically linked through gimbals to the gyro motor, so that they provide a change in output for any change in Directional Gyro CN-998/ASN-43 azimuth position. The stator of the heading synchro provides a three-wire stabilized reference output signal. The slaving synchro also provides a stabilized reference output signal to the ID-998/ASN. The heading synchro stator signals leave the CN-998/ASN-43 on pins G, H, and J of P411 and are routed to pins 1, 2, and 3 of ID-998/ASN.

c. MAG Mode. Magnetic (MAG) mode of operations is selected by setting compass slaving switch, located on pilot's instrument panel, to MAG position. In MAG mode the CN-998/ASN is slaved to the earth's magnetic field. The Transmitter, Induction Compass T-611/ASN is excited by 23.5 volts ac, 400 Hz, from power transformer T1 in the CN-998/ASN-43. The T-611/ASN senses the direction of the horizontal component of the earth's magnetic field and produces a three-wire 800 Hz output reference signal. Stray magnetic fields in the aircraft causing an error in the T-611/ASN are compensated for by Compensator, Magnetic Flux CN-405/ASN. The three-wire signal produced by the CN-998/ASN-43 leave on pins G, H, and J and enter the ID-998/ASN on pins 1, 2, and 3.

2-12. Iff System Operation (AN/APX-44)
(fig. FO-11 and FO-12)

a. Power Distribution. With AN/APX-44 circuit breaker depressed and master control on the Control, Transponder Set C-2714/APX-44 set to STBY, LOW, HIGH, or EMER, +28 volts dc is applied to pin 44 of J902 in Receiver-Transmitter RT-494/APX-44 through an energized power relay. The ground circuit for the power relay is completed through pin H of P901 on the C-2714/APX-44.

b. Audio Distribution. Audio signals from the IFF transponder facility are routed from pin 35 of J902 on the RT-494/APX-44 to pin S of J901 on the C-2714/APX-44. Audio signals leave C-2714/APX-44 on pin T and are routed to pin 27 on J301A and J301F signal distribution panels. Each time pilot's or gunner's ICS radio switch is pushed to RADIO or gunner's foot switch is depressed, a ground path is established from pin H of J34 (or pin H of J91) to pin 4 of J600 (or pin 5 of J600) on impedance matching assembly. The ground is routed through the deenergized contacts of K8 and out of J600 on pin 31 to pin 13 of P907, then to pin P of P901 on the C-2714/APX-44. On the C-2714/APX-44, if the MIC position on I/P switch is selected each time RADIO switch is closed, the AN/APX-44 system is energized for 30 seconds.

2-13. Iff System Operation (AN/APX-72)
(fig. FO-12, FO-12.1 and FO-12.2)

a. Power Distribution. With IFF XPDR circuit breaker depressed and master control on the Control, Transponder C-6280/APX set to STBY, LOW, HIGH, or EMER, +28 volts dc is applied to pin 2 of J906 on Receiver-Transmitter RT-859/APX-72 through an energized power relay. The ground circuit for the power relay is completed through pin 53 of P907 on the C-6280/APX.

b. Audio Distribution. Audio signals from the IFF transponder facility are routed from pin 51 of J906 on the RT-859/APX-72 to pin 55 of J907 on the C-6280/APX. Audio signals are routed to pin 27 on J301A and J301F signal distribution panels. Each time the pilot's or gunner's radio switch is set to RADIO or the gunner's foot switch is depressed, a ground path is established betweeen pin H of J34 (or pin H of J91) and pin 4 of J600 (or pin 5 of J600) on impedance matching assembly. The ground is routed out of J600 on pin 31 to pin 9 of P906. On the C-6280/APX, if the MIC position on I/P switch is selected each time the RADIO switch is closed, the AN/APX-72 system is energized for 30 seconds.

2-14. Vhf Command Operation (fig. FO-7, FO-8 and FO-8.1)

a. Power Distribution.

(1) *Receiver circuits.* Depressing the VHF RCVR circuit breaker on the dc circuit breaker panel applies +27.5 volts dc to pins 3 and 4 of J1904A of the Receiver-Transmitter, Radio RT-857/ARC-134 and to pin *a* of J1901 of the contact unit. Placing the OFF/PWR switch on the Control, Radio Set C-7197/ARC-134 to the PWR position connects a ground to the coil of the power control relay. The power control relay is energized and the +27.5 volts dc is connected to the relay contacts to energize the receiver portion of the RT-857/ARC-134 circuits in the receive mode.

(2) *Transmitter circuits.* Placing the TRANS selector switch on the C-1611(*)/AIC in position 3 and pressing the pilot's or gunner's cyclic stick switch to the up position or depressing the gunner's foot switch applies a ground to the push-to-talk switch in the RT-857/ARC-134. This energizes push-to-talk relay which then applies +27.5 volts dc to the transmitter circuits of the RT-857/ARC-134. The receiver circuits are disabled during the transmit mode.

b. Audio Distribution.

(1) *Audio reception.* Audio signals from the AN/ARC-134 are routed from pin 35 of J1904B of the RT-857/ARC-134 to pin 15 of J600 through R26 and out pin 17 of J600, to pin 12 of J1904A (audio muting control) and out on pin 11 of J1904A to pin e of J1901 of the C-7197/ARC-134. Audio signals are routed through the volume control of the C-7197/ARC-134, out pin d of J1901, and to pin 32 of C-1611(*)/AIC panels where the signals are amplified and routed to pin 2 of TB22, TB23, then to the headset portions of headset-microphones.

(2) *Audio Transmission.* With the TRANS selector switches on the C-1611(*)/AIC in position 3, and with the pilot's or gunner's cyclic stick switch pressed to the RADIO position or the gunner's foot switch depressed, audio signals are transmitted out pin 26 of J301A or J301F to pin 14 (pin 16 for gunner) of J600, through R24 (R23 for gunner), through R25 and coupling condenser C3, out pin 18 of J600 to pin 30 of J1904A at the RT-857/ARC-134.

CHAPTER 3

DIRECT AND GENERAL SUPPORT MAINTENANCE

Section I. GENERAL MAINTENANCE TECHNIQUES

WARNING

When servicing the electronic equipment configuration in Army model AH-1G and AH-1Q helicopters be extremely careful because of high voltages present in various electronic equipment components. Always disconnect power before attempting to make resistance measurements.

3-1. General Instructions

a. The direct and general support electronic equipment configuration maintenance procedures in this chapter supplement the organizational maintenance procedures in TM 11-1520-221-20. In addition, these procedures supplement the procedures given in the separate technical manuals on the electronic equipments to provide complete repair and maintenance instructions for all electronic equipments.

b. The direct and general support electronic equipment configuration maintenance procedures are performed in systematic order. Systematic maintenance begins with functional operation and sectionalization check that can be performed within the helicopter, and those checks are followed by procedures for removal and replacement of units or components. Systematic maintenance continues with troubleshooting and bench maintenance of the individual electronic equipment components which are removed from the helicopter. Paragraphs 3-4 through 3-9 provide direct and general support troubleshooting and repair of electronic equipment configurations within the helicopters as a supplement to the organizational maintenance procedures. As a supplement to the separate technical manuals on the individual electronic equipment, paragraphs 3-10 through 3-13 provide direct and general support troubleshooting and repair of electronic equipment components that have been removed from the helicopter.

3-2. Organization of Troubleshooting Procedures

a. General. Troubleshooting the electronic equipment configurations in Army model AH-1G and AH-1Q helicopters is performed in two steps. The first step, sectionalization, is to trace the fault to a facility used in a system of the configuration. The second step, localization, is to trace the trouble to the defective unit that is part of the faulty facility or associated junction box, cabling, or wiring. When performing bench maintenance on a removed electronic equipment component, localization includes tracing the trouble to the defective component responsible for the abnormal condition. After determining the defective component, refer to the applicable manual (app. A) for procedures for isolating the trouble to a defective part.

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work and to aid in tracing faults to defective facilities.

(1) *Visual inspection.* Visual inspection to locate faults before operating or testing circuits includes checking seating of all component connectors, checking connections to switches and circuit breakers, and checking connections on terminal boards, connections to antennas, and other visible details.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. The periodic preventive maintenance check and service chart (TM 11-1520-221-20) may be used for an operational test.

c. Localization. The procedures listed below are used for localizing facility troubles to the electronic equipment components or wiring of the Configuration Refer to TM 11-1520-221-20 for physical location of junction boxes, control boxes, receivers, and transmitters.

(1) *Configuration interunit troubleshooting.* Configuration interunit troubleshooting in para-

graphs 3-4 through 3-6 includes a troubleshooting chart for each facility. These charts are used to localize to a particular unit or component the cause of a trouble within a malfunctioning facility.

(2) *Voltage measurements.* The voltage measurement chart (para 3-7) is used when the applicable facility troubleshooting chart does not correct a fault or indicates that voltage measurements are required.

(3) *Electronic equipment troubleshooting.* The troubleshooting charts given in paragraph 3-6 will aid in localizing the cause of a trouble within an electronic equipment component.

(4) *Intermittent troubles.* In all tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment and checking wiring and connections to the components.

3-3. Test Equipment, Tools, and Materials Required

a. Test Equipment. The following chart lists the test equipment required for troubleshooting the complete electronic equipment configurations and specific electronic equipment components in Army model AH-1G and AH-1Q helicopters. Also listed is the associated manual for each item of test equipment.

Test equipment	Technical manual	Use
Multimeter AN/URM-105	TM 11-6625-203-12	In-aircraft troubleshooting
Electronics Equipment Maintenance Kit MK-731 ARC-51X.	TM 11-6625-564-12	In-aircraft troubleshooting
Wattmeter AN URM-120	TM 11-6625-446-15	In-aircraft troubleshooting

b. Tools and Materials.

(1) Tool Kit, Electronic Repairman TK-100/G.

(2) Tool Kit, Electronic Repairman TK-101/G.

(3) Varnish, Corrosion and Fungus Resistant MIL-V-173.

Section II. CONFIGURATION INTERUNIT TROUBLESHOOTING

3-4. Introduction

a. When a malfunction of an electronic equipment occurs, the first step in correcting the trouble is to sectionalize the cause to a particular unit in the aircraft (helicopter). Perform the operational checks in the periodic preventive maintenance check and service chart (TM 11-1520-221-20). If the operational checks and supporting troubleshooting chart are inconclusive as to which unit or item is causing the trouble, perform the direct and general support in-aircraft troubleshooting procedures in this section for the particular defective facility.

NOTE

Troubleshooting procedures for electronic equipments that have been removed from the helicopter are covered in paragraphs 3-12 and 3-13.

b. The direct and general support in-aircraft troubleshooting procedures involve the use of special portable test equipments that are not allocated at the organizational maintenance level. Since the controls for the electronic equipments and the other basic components are remotely located, the troubleshooting procedures in this section require more than one person. The organizational maintenance repairman should remain in the operator's compartment to operate the controls in accordance with the commands from the direct or general support maintenance repairman. The direct support maintenance repairman will then connect the test equipments (para 3-5) and perform the procedures outlined in paragraph 3-6.

3-5. Facility Test Setup AN/ARC-51BX

a. Radio Set Simulator (Part of Electronics Equipment Maintenance Kit MK-731/ARC-51X). By substituting the radio set simulator for the receiver-transmitter, the following tests and measurements of the remaining units or circuits in the aircraft can be made:

(1) Polarity of the aircraft power source.

(2) Magnitude of power source voltage under simulated load during both transmit and receive.

(3) Receive audio system.

(4) Microphone audio system.

(5) Frequency control selector system.

(6) Transmit/receive T/R) control circuit.

(7) Guard receiver control circuit.

(8) Adf control circuit.

(9) Antenna and RF circuits.
(10) Shielded ground connections.
(11) SENS control circuit.
(12) Auxiliary audio circuit.

b. Radio Set Simulator Installation.

(1) Turn the radio set control function select switch to OFF. Turn the main power control switches on all other equipment associated with the radio set to OFF. However, close all aircraft circuit breakers associated with the radio set.

(2) Disconnect aircraft cable connectors P1401 and P1403 from the RT-742(*)/51BX jacks J1401 and J1403. Disconnect the antenna cable connector from reflectometer plug P1405.

(3) Loosen the RT-742(*)/51BX wingnut fasteners so they can be disengaged from the mounting, and slide the RT-742(*)/51BX off the Mounting MT-2653/ARC. Do not remove the reflectometer or external blower from the RT-742(*)/51BX.

(4) Remove the radio set simulator from its storage location within the Electronics Equipment Maintenance Kit MK-731/ARC-51X carrying case. Attach the radio set simulator to the mounting tray which is provided. Slide the radio set simulator and mounting tray onto the mounting in the helicopter. Engage the wingnut fasteners, and tighten to secure the radio set simulator in place.

c. Cable Connections, Radio Set simulator.

(1) Connect helicopter cable connectors P-1401 and P1403 to radio set simulator jacks J1401 and J1403 respectively.

(2) Connect the helicopter antenna cable to radio set simulator jack J3.

(3) Plug Headset H-101A/U into the radio set simulator Headset H-101A/U jack.

d. In-Aircraft Troubleshooting Radio Set AN/ARC-51BX. By performing the in-aircraft troubleshooting procedures as described in this section, a complete check of the remaining units associated with the AN/ARC-51BX can be accomplished. The procedures are listed so that if unsatisfactory indications are obtained for a particular step, the trouble can be sectionalized to a particular circuit or unit. If the results of the troubleshooting procedures are completely satisfactory, it can be assumed that the cause of trouble is within the RT-742(*)/51BX.

Step	*Action*	*Normal indication*	*If abnormal indications are observed*
1	Radio set: Turn radio set simulator TEST SELECTOR switch to +27.5 VDC. Set radio set simulator POWER switch to ON.	Radio set simulator multimeter indicates within green sector. Radio set simulator +27.5 VDC indicator lamp lights.	Helicopter power source is cause of trouble. Check polarity and continuity of 27.5-volt dc helicopter wiring.
2	Cocknit: Turn C-6287/ARC-51BX function select switch to T/R.	Radio set simulator T/R indicator lamp lights.	The C-6287/ARC-51BX function selector switch or aircraft power on-off control wiring is cause of trouble.
3	Radio set simulator: Check aircraft intercom system by talking into H-101A/U microphone.	Audio from radio set simulator heard at pilot's H-101A/U in cockpit.	Trouble may be caused by faulty pilot's H-101A/U. Substitute for H-101A/U to check this possibility. If R-101A/U is good, proceed with tests to pinpoint cause of trouble in helicopter audio system.
4	Cockpit: Rotate C-6287/ARC-51BX VOL control from full clockwise to full counterclockwise position.	Corresponding increase and decrease of audio level at pilot's H-101A/U.	The C-6287/ARC-51BX control VOL control circuit is cause of trouble. Refer to TM 11-5820-518-35.
5	Radio set simulator: Turn radio set simulator TEST SELECTOR switch to REMOTE SENS.	Radio set simulator multimeter indication varies from 0 to at least 8 (scale A) as SENS control is rotated.	The C-6287/ARC-51BX SENS control or associated aircraft wiring is cause of trouble. Refer to TM 11-5820-518-35.
6	Cockpit: a. Rotate C-6287/ARC-51BX SENS control from full counterclockwise to full clockwise position.	***Caution:*** Do not drive multimeter indicator beyond full scale.	
	b. Turn C-6287/ARC-51BX SQ	Radio set simulator SQ DIS indicator	The C-6287/ARC-51BX squelch dis-

Step	Action	Normal indication	If abnormal indications are observed
	DISABLE switch to ON position.	lights.	able switch or associated aircraft wiring is cause of trouble. Refer to TM 11-5820-518-35.
7	Cockpit: Press push-to-talk switch on pilot's control, and talk into H-101A/U microphone.	Radio set simulator XMIT indicator lights. Audio from cockpit heard at radio set simulator H-101A/U headset. Sidetone audio heard at pilot's H-101A/U headset in cockpit.	Pilot's push-to-talk control or aircraft T/R control wiring is cause of trouble. Aircraft audio system is cause of trouble. Check for open circuits or short circuits to ground on headset and microphone audio connections.
8	Radio set simulator: Turn radio set simulator TEST SELECTOR switch to SHIELD GROUND.	Radio set simulator multimeter indicates within the green sector of scale A.	Helicopter interconnecting cable containing shielded audio conductors is cause of trouble.
9	Cockpit: Turn radio set control function selector switch to T/R+G.	Radio set simulator T/R+G indicator lights.	The C-6287/ARC-51BX function selector switch or helicopter guard receiver control wiring is cause of trouble. Refer to TM 11-5820-518-35.
10	*a.* Cockpit: Return C-6287/ARC-51BX function selector switch to T/R.		
	b. Radio set simulator: Turn radio set simulator TEST SELECTOR switch to +27.5 VDC. Operate radio set simulator XMIT LOAD switch to ON momentarily.	Radio set simulator multimeter indicates within the green sector and remains there during XMIT LOAD switch operation. Radio set simulator XMIT LOAD indicator lights during test.	Helicopter power source is cause of trouble. Check for cause of low voltage under simulated transmit load conditions.
11	Radio set simulator: Turn radio set simulator TEST SELECTOR switch to VSWR CAL. Press radio set simulator PTT switch, and adjust VSWR CAL control until multimeter indicates on CAL mark (scale B). Switch radio set simulator TEST SELECTOR switch to VSWR TEST and press PTT switch.	Radio set simulator multimeter indication does not exceed green sector of scale B with an SWR of 3:1 or less.	Trouble is caused by either the helicopter antenna or RF cable between reflectometer jack J1 and helicopter antenna.
12	*a.* Cockpit: Turn C-6287/ARC-51BX 10-mc control through all positions.		
	b. Radio Set simulator: Verify radio set simulator frequency readout.	Radio set simulator frequency readout agrees with radio set control MEGACYCLES indicator at each position of 10-mc control.	The C-6287/ARC-51BX 10-mc control switch or aircraft wiring associated with 10-mc frequency control is cause of trouble.
13	*a.* Cockpit: Turn C-6287/ARC-51BX 1 mc control through all positions.		
	b. Radio set simulator: Verify radio set simulator frequency readout.	Radio set simulator frequency readout agrees with radio set control MEGACYCLES indicator at each position of 1-mc control.	The C-6287/ARC-51BX 1-mc control switch on aircraft wiring associated with 1-mc frequency control is cause of trouble.
14	*a.* Cockpit: Turn C-6287/ARC-51BX 1-mc control through all positions.		

Step	Action	Normal indication	If abnormal indications are observed
	b. Radio set simulator:		
	Verify radio set simulator frequency readout.	Radio set simulator frequency readout agrees with radio set control MEGACYCLES indicator at each position of .1-mc control.	The C-6287/ARC-51BX .1-mc control switch or aircraft wiring associated with .1-mc frequency control is cause of trouble.

3-6. Facility Troubleshooting

Direct and general troubleshooting charts for each facility in each configuration are contained in *a* through *g* below. When using the troubleshooting charts to determine the cause of malfunction, go directly to the facility in which the malfunction is reported, start at the beginning of these procedures, and follow each step in order. If the indicated checks in the "If abnormal indications are observed" column fail to locate the trouble, perform the voltage measurements given in paragraph 3-7. When the trouble is localized to a basic electronic equipment item, remove the item from the helicopter and perform the electronic equipment unit troubleshooting procedures (sec. IV) to determine the trouble within the malfunctioning electronic equipment item. Depress all communication and navigation circuit breakers.

a. Interphone and Audio Facility (fig. FO-2, FO-3, FO-4 and FO-4.1).

Step	Action	Normal indication	If abnormal indications are observed
1	On C-1611(*)/AIC (interphone panels) turn transmit-receive selector switch to INT.		
2	Place microphone switch on cyclic grip to ICS (down) position. Speak into microphone.	Sidetone heard in H-101/U headsets.	Check that H-101/U headset-microphone jack is properly inserted. Check for +28 volts dc at pin 37 of C-1611(*)AIC.

b. Fm Liaison and Fm Homing Facilities (fig. FO-5).

Step	Action	Normal indication	If abnormal indications are observed
1	Turn mode control on C-3835/ARC-54 to PTT.	Radio set is energized	Probable trouble with FM ARC-54 circuit breaker. Check for 28 volts dc at FM circuit breaker. Check for +28 volts dc at pins, 18, 34, and 36 of J2106 on RT-348/ARC-54. Check for +28 volts dc at pins C, D, and E of J2107 on C-3835/ARC-54.
2	On C-3835/ARC-54, turn mode control to PTT, turn volume control to increase.	Minimum background noise heard in H-101/U.	Adjust squelch adjustment. Refer to TM 11-1520-221-20.
3	Turn transmit-interphone switch on C-1611(*)/AIC to number 1.	Received signal should be loud and clear.	Check for correct frequency selection on C-3835/ARC-54. Probable faulty antenna cable or connector.
4	Establish two-way communication with local fm station.	Transmitted signal should be loud and clear.	Probable trouble in RT-348/ARC-54. Probable trouble in fm antenna. Probable trouble in C-3835/ARC-54. Improper frequency set in C-3835/ARC-54.
5	While keying the RT-348/ARC-54 and talking into H-101/U, set the meter selector switch on RT-348/ARC-54 to each of 12 positions.	In each position the meter should indicate between 3 and 7 except in position 11 which should not exceed 8. Position 12 represents OFF.	Probable faulty RT-348/ARC-54. Probable trouble in fm antenna. Probable trouble in RT-348/ARC-54.
6	Set mode control switch to HOME.	Vertical pointer flag should disappear and the vertical pointer should deflect left or right, depending on bearing to transmitter; indicator pointer remains centered if aircraft	Probable trouble in RT-348/ARC-54. Received signal strength inadequate. Probable defective ID-48(*)/ARN.

Step	Action	Normal indication	If abnormal indications are observed
		is aligned with bearing to transmitter.	

c. Vhf Command Facility (fig. FO–7, FO–8 and FO–8.1).

Step	Action	Normal indication	If abnormal indications are observed
1	Set OFF PWR switch to PWR.	Indicator dials should glow	If indicator dials do not glow, replace Radio Control Set C-7197/ARC-134.
2	Turn VOL control clockwise	A rushing noise should be heard in the headset.	If no noise heard in headset check Receiver-Transmitter RT-857/ARC-131. Refer to TM 11-5821-277-25-1.

d. Uhf Command Facility (fig. FO–6 and FO–6.1).

Step	Action	Normal indication	If abnormal indications are observed
1	Set function selector switch to T/R position.	External blower operates	Check uhf circuit breaker. Check fuse F1 in RT unit.
2	Turn VOL control clockwise	Loud noise in headset	Check VOL control switch. Check C-6287/ARC-51BX.
3	Turn SENS control fully counterclockwise.	No audio heard in headset	Check SENS control. Check C-6287/ARC-51BX.

e. Adf Direction Finding (fig. FO–9).

Step	Action	Normal indication	If abnormal indications are observed
1	Set function switch to ADF	Frequency window is illuminated	Check ADF circuit breaker. Check ADF function switch.
2	Set BFO-OFF switch to OFF	No cw in headset	Check BFO-OFF switch. Check R-1391/ARN-83.
3	Rotate loop switch	Bearing indication pointer rotates	Replace control unit.

f. Gyro-Magnetic Compass Facility (fig. FO–10).

Step	Action	Normal indication	If abnormal indications are observed
	Power on	ID-998 ASN power failure indicator disappears.	Check GYRO COMP circuit breaker. Check ID 988/ASN.

g. Iff system Facility (fig. FO–11, FO-12, FO–12.1 and FO–12.2).

Step	Action	Normal indication	If abnormal indications are observed
1	Set master control switch to STBY.	Pilot light illuminates	Check for 28 volts dc at circuit breaker. Check fuse F101.
2	Set master control switch to mode 1.	Appropriate flags appear on transponder test set.	Check pilot light. Check control unit. Check RT unit. Check antenna.

3–7. Voltage Measurement Chart

Use the voltage chart below when troubleshooting the electronic equipment configuration in helicopter. When a trouble develops in a facility and the applicable facility troubleshooting chart does not correct the fault or indicates that voltage measurements are necessary, refer to this chart and make the voltage measurements shown for the applicable terminals. When a measurement does not correlate with the chart, refer to the electronic equipment configuration schematic wiring diagram (TM 11–1520–221–20) and trace the wiring until the difficulty is found. Before making measurements, connect an auxiliary power unit (TM 11–1520–221–20). Operate the equipment from the pilot's controls after pressing the pilot's RADIO CONTROL switch.

Terminal	Facility	Function	Operation of equipment	Voltage
		TB 21 Communication impedance matching assembly		
1	Fm liaison	Power to fm liaison set	Fm liaison facility on	+28 vdc
2, 3, and 4	Interphone	Common ground	Ground	Zero
		TB 6 Panel lights		

Terminal	Facility	Function	Operation of equipment	Voltage
1, 2	Panel lights	Power to panel lights	Light control fully on	+28 vdc
		TB 2 Panel lights		
5	Panel lights	Power to panel lights	Light control fully on	+28 vdc
		TB 22 gunner's headset		
1	Interphone	Gunner's H-101/U earphone audio-common.	Interphone facility turned on	Zero
2	Interphone	Gunner's H-101/U earphone audio-high.	Interphone facility turned on	Audio
3	Interphone	Gunner's H-101/U microphone audio-high.	Interphone facility turned on	Audio
4	Interphone	Gunner's H-101/U microphone audio-low.	Interphone facility turned on	Zero
5	Interphone	Gunner's H-101/U headset cord and cable shield.	Interphone facility turned on	Zero
		TB 23 Pilot's headset		
1	Interphone	Pilot's H-101/U earphone audio-common.	Interphone facility turned on	Zero
2	Interphone	Pilot's H-101/U earphone audio-high.	Interphone facility turned on	Audio
3	Interphone	Pilot's H-101/U microphone audio-high.	Interphone facility turned on	Audio
4	Interphone	Pilot's H-101/U microphone audio-low.	Interphone facility turned on	Zero
5	Interphone	Pilot's H-101/U headset cord and cable shield.	Interphone facility turned on	Zero

3-8. Gyromagnetic Facility Alignment

a. Secure all magnetic equipment aboard the helicopter into normal flight position.

b. Position the helicopter on a compass rose away from any abnormal magnetic fields such as cars, buildings, and electrical equipment. No magnetic tools, jacks, or handling equipment can be used during alignment, and operators must not carry any magnetic material, such as watches, keys, safety shoes, and flashlights.

c. Energize the compass facility and let it warm up for ten minutes. The slaving switch should be set to the MAG position.

d. Set flux Compensator, Magnetic Flux CN-405/ASN adjusting screws (N-S and E-W) to align their dots with the dots on the CN-405/ASN case.

e. Loosen the Transmitter Induction Compass T-611/ASN mounting screws and align the T-611/ASN with the helicopter's fore/aft axis.

f. Slowly rotate the helicopter at least one full turn while watching Radio Magnetic Compass ID-998/ASN. The ID-998 motion should be smooth and the bearing should approximate the heading of the helicopter.

g. Point the helicopter on an east magnetic heading. Note the heading shown on the ID-998/ASN and determine the deviation.

h. Repeat step *g* for south, west, and north magnetic headings.

i. Calculate the average of the four deviations.

j. Rotate the T-611/ASN the number of degrees and in the opposite direction to that of the average deviation. For example, if the average deviation was minus 6 degrees, the compass would be rotated 6 degrees positive.

k. Repeat steps *g* through *j* to achieve maximum accuracy. Tighten the T-611/ASN mounting screws and note the heading measurements for reference.

l. Point the helicopter on a north magnetic heading.

m. Subtract the south deviation from the north deviation (determined from notes made in step *k*) and divide the result by 2.

n. Adjust the N-S ID-998/ASN screw so that the indication on the ID-998/ASN moves by the amount and in the direction calculated in step *m*. For example, if the heading was 358 degrees and the calculation in step *m* was plus 1.5 degrees, the N-S screw would be adjusted for a heading of 359.5 degrees.

o. Repeat step *n* with the helicopter pointing on a south magnetic heading.

p. Point the helicopter on an east magnetic heading.

q. Subtract the west deviation from the east deviation (determined from notes made in step *k*) and divide the result by 2.

r. Adjust the E-W CN-405/ASN screw so that the indication on the ID-998/ASN moves by the amount and in the direction calculated in step *q*. For example, if the heading was 90 degrees and the calculation in step *q* was plus 0.75 degree, the E-W screw would be adjusted for a heading of 89.75 degrees.

s. Repeat step *r*, with the helicopter pointing on a west magnetic heading.

t. Repeat steps *g* through *s* until all deviations are less than 2 degrees.

u. Make measurements of heading deviation, one at every 30-degree increment on the compass rose. Record the deviations on the compass correction card, along with the T-611/ASN, CN-405/ASN, and ID-988/ASN serial numbers.

v. Seal the N-S and E-W screws with lacquer.

3-9. Main and Standby Inverter Adjustment (AH-1G)

Periodic Check-Inverter Output. Perform following procedures to check inverter outputs:

NOTE

Both the main and standby inverter outputs should be checked in conjunction with each periodic inspection.

a. Remove access panel directly above ammunition compartment door on left side of helicopter (helicopters 68-15000 and subsequent for main (250 va) inverter location, open aft compartment access door).

NOTE

To properly conduct this inverter check, it will be necessary to apply a regulated DC ground power source or ground run the helicopter to assure an adequate source of DC power for inverter operation. Under no circumstances will helicopter battery power be used.

b. Turn on main inverter. Close all AC circuit breakers. Actuate the following AC circuits to produce maximum demand on main inverter:

AC 115 Volt
AC Failure Relay
Attitude Indicator
Fuel Quantity
AN/ASN-43
SAS Power
Transformer (25 volt)
Weapon Power
Inverter Balance
AC 26 Volt
Indicator, Course ID-250/ARN
Attitude Indicator (Gunner)
Engine Oil Pressure
Fuel Pressure
Indicator, Radio-Magnetic Compass ID-998/ASN
Torque Pressure
Transmission Oil Pressure

c. Using the most accurate AC voltmeter available, check output voltage at terminal(s) B1 and X2 of transfer relay (K9) located on bulkhead directly above inverters. If output voltage is found to be within 107 to 115 volts, no adjustment is necessary.

NOTE

(Helicopters 68-15000 and subsequent) Connect the AC voltmeter and a frequency meter to the 115 vac Bus at the engine vibration receptacle or other convenient monitoring point. Check that the AC bus voltage is 115 ±2.5 vac and the frequency is between 380 and 420 Hz.

d. Should output voltage be above or below the prescribed range of 107 to 115 volts, proceed as follows. Turn off DC power to inverter. Dismount inverter from helicopter structure. Remove cover from end of inverter that normally faces toward nose of helicopter. Reconnect bonding jumper to base of inverter. Loosen hex-head jam nut securing adjustment screw.

e. Close all AC circuit breakers. Actuate all AC circuits. Turn on inverter power. Connect voltmeter across terminals B1 and X2 of transfer relay (K9). Note reading. Turn inverter output adjustment screw clockwise to increase, or counterclockwise to decrease inverter output. Nominal setting of 111 volts at full output load should produce an output frequency within limits of 380 to 420 Hz. See figure 3-1 for directional references.

NOTE

(Helicopters 68-15000 and Subsequent) The voltage (VOLT) and frequency (FREQ) adjustment screws are located on the end of the inverter (Main) adjacent to the power receptacle.

NOTE

If frequency measuring equipment is available, it is highly recommended a frequency check be accomplished in conjunction with voltage check. If frequency check reveals frequency is not within

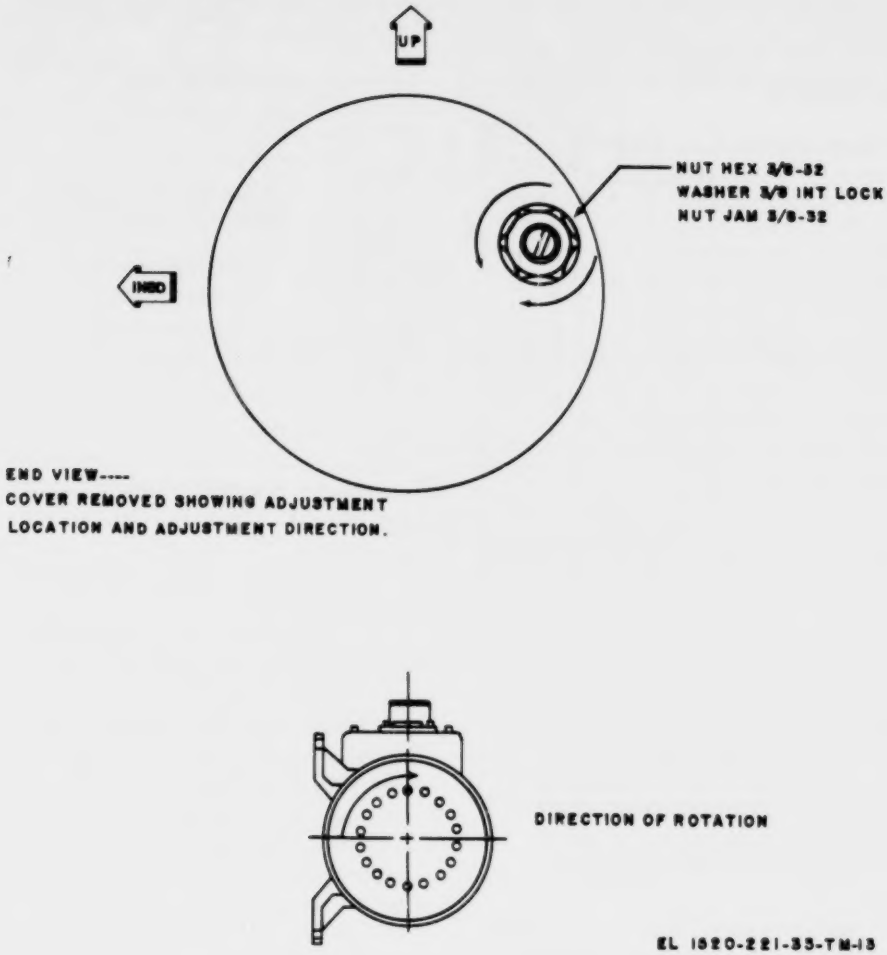

Figure 3-1. Adjustment of main inverter (PU-542(A)/A or PU-543(*)/A).

the high low limit (380 or 420), voltage should be adjusted upward or downward to bring frequency within range.

f. Check and adjustment procedure is essentially the same for the static inverter (located adjacent to main inverter) with the exception that inverter need not be removed from the aircraft or disassembled to gain access to adjustment screws. Connect voltmeter test lead to terminals B3 and X2 of transfer relay K9.

g. Voltage adjustment screw is located at upper right corner of inverter. Adjustment is accomplished by inserting a small insulated screw driver through perforated cover of inverter, engaging slots in adjustment screw. Turn counterclockwise to increase voltage or clockwise to decrease voltage. See figure 3-2 for directional references.

NOTE

Frequency output of the static inverter is electronically controlled and is not a function of RPM as is the case with the rotary inverter; however, if frequency check equipment is available, it is highly recommended that a frequency check be accomplished in conjunction with the voltage check. Should it become necessary to readjust frequency output of the static inverter, adjustment screw is located at lower right corner of inverter.

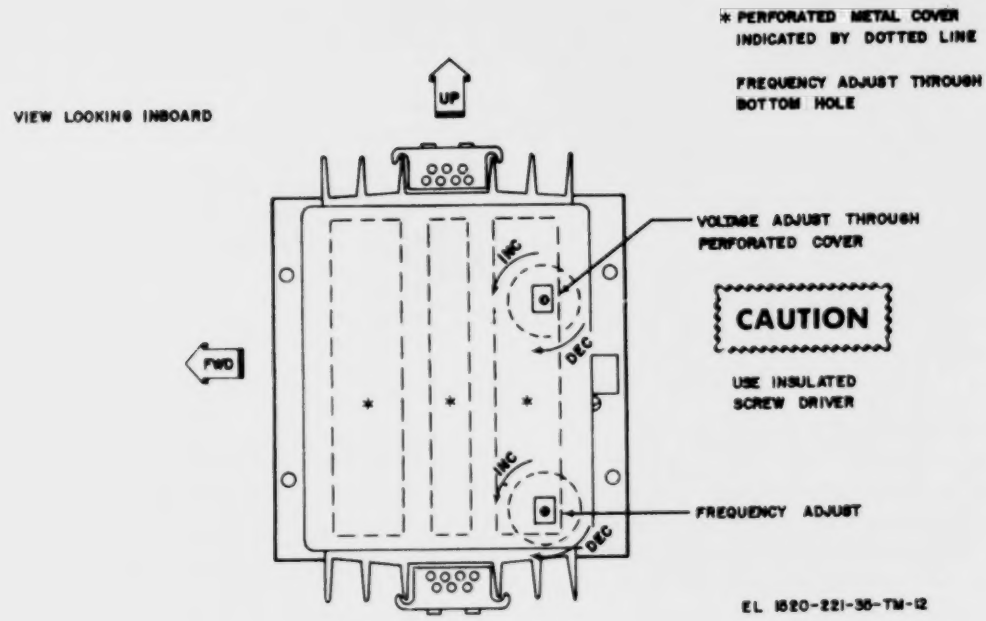

Figure 3-2. Adjustment of standby inverter (PP-6508B/U).

Adjustment is accomplished by inserting an insulated screw driver through perforated cover, engaging slots in adjustment screw. Turn screw counterclockwise to increase frequency output or clockwise to decrease output frequency.

h. Should readjustment of the static inverter become necessary, adjust to 115 volts 400 Hz with full AC load applied.

3-9.1. Main and Standby Inverter Periodic Output Check (AH-1Q)

a. Place NON ESS BUS switch (S4) to NORMAL. Close MAIN INV, STBY INV, CAUTION LTS, and AC FAIL RLY circuit breakers. Check that INST INVERTER caution light illuminates.

b. Place INV selector switch (S3), located on pilot's electrical control panel, to MAIN position. Check that main inverter is energized. Check that INST INVERTER caution light is extinguished.

c. Connect an ac voltmeter and a frequency meter to the essential 115-volt ac bus at engine vibration receptacle or other convenient monitoring point. Set essential bus voltage to 28 ± 0.5 volts. Check that ac bus voltage is 115 +3.5, -6.5 volts and that frequency is 400 ± 10 Hz.

d. Switch TOW system on. Check for 115 +3.5, -6.5 volts ac between each of the two active circuits on TOW PWR circuit breaker (CB76) and ground. Check that essential ac bus remains energized and that INST INVERTER caution light remains extinguished.

e. Switch TOW system off. Check for no voltage on the active circuits on the TOW PWR circuit breaker. Check that essential bus is energized and INST INVERTER caution light is extinguished.

f. Open MAIN INV circuit breaker. Check that main inverter is deenergized and that INST INVERTER caution light is illuminated.

g. There is no external adjustment controls, therefore, all adjustments must be conducted by a higher level of maintenance. Remove and replace inverter if inspection requirements are not met.

NOTE

Refer to paragraph 3-9 for checking and adjusting the standby inverter.

Section III. ELECTRONIC CONFIGURATION REPAIRS AND ALIGNMENT

3-10. General

The repair and alignment procedures that can be performed in the helicopter by direct support maintenance personnel are covered in section IV. These procedures supplement the organizational maintenance repairs and alignment in TM 11-1520-221-20 to provide complete repair and alignment procedures for the electronic equipment configurations. For repair and alignment procedures on electronic equipments that have been removed from the helicopter, refer to paragraphs 3-12 and 3-13.

3-11. Removal and Replacement of Components

Removal and replacement of all electronic equipments, including those parts within the impedance matching box, are covered in the helicopter organizational manual TM 11-1520-221-20.

Section IV. ELECTRONIC EQUIPMENT UNIT TROUBLESHOOTING AND REPAIR

3-12. General

Direct and general support troubleshooting and repair of electronic equipment components that have been removed from helicopters, except impedance matching assemblies, are covered in the separate technical manuals for the individual equipments (app. A).

3-13. Troubleshooting and Repair of Impedance Matching Network Assemblies (P/N 209-075-235) (fig. 2-1, 2-2, 2-2.1, 2-3 and 2-3.1)

a. Types of Troubles. Three types of troubles are encountered in the impedance matching network: defective components, defective conductors, or defective printed circuit boards P/N 209-075-246. Replace broken, cracked, or blistered boards.

CAUTION

Use only pencil-type soldering irons with a maximum rating of 25 watts when repairing impedance matching network.

b. Coating. The impedance matching network assemblies on the printed circuit boards are coated with protective coating MIL-V-173. Remove protective coating from the immediate area before making repairs. When repairs are completed, apply new protective coating. Removal and application procedures for the protective coating are given below:

WARNING

Trichloroethylene is toxic. Avoid breathing the fumes. Perform cleaning in a well ventilated area, using a clean, lint free cloth. If solvent comes in contact with the skin, wash the skin throughly with soap and water immediately.

(1) *Removal of protective coating.* If repairs are extensive, soak the board in trichloroethylene to soften the protective coating. Wipe the area clean with a lint free cloth. If repairs are minor, carefully scrape the protective coating from the area to be repaired; use a knife or similar sharp tool.

(2) *Application of protective coating.* If the entire protective coating was removed during repair, replace the coating by spraying two coats of varnish, moisture and fungus resistant, MIL-V-173, on both sides of the board. If the repairs were minor in nature, brush-apply two coats of varnish to the affected area.

c. Replacing Defective Parts. Replace defective parts as follows:

NOTE

Resistor and capacitor color code diagrams (fig. FO-1) are provided to air maintenance personnel in determining the value, voltage rating, and tolerance of capacitors and resistors.

(1) Remove the defective part by cutting its leads near mounting holes on the part-bearing side of the board.

(2) Remove protective coating as directed in *b*(1) above.

CAUTION

Do not apply heat longer than necessary; prolonged heating can damage the board.

(3) Apply heat at the mounting holes until the solder is melted, and remove remaining pieces of the part's wire leads.

(4) Heat the solder in the mounting holes and remove it with a stiff bristle brush.

(5) Bend the leads of the replacement part to fit the mounting holes.

(6) Insert the leads in the mounting holes, and press the part firmly against the board.

(7) Cut the leads approximately one-eighth inch from the wiring side of the board.

(8) Bend and press the leads against the printed circuit conductor.

(9) Using a heat sink, solder the replacement part to the printed circuit conductor.

(10) Coat the new part and the repaired area with protective coating as directed in *b*(2) above.

CHAPTER 4

DIRECT AND GENERAL SUPPORT TESTING PROCEDURES

4-1. General

a. Testing procedures are prepared for use by maintenance shops and supporting service organizations responsible for performing direct and general support maintenance on avionic equipments to determine the acceptability of repaired equipments. These procedures set forth specific requirements that a repaired electronic equipment must meet before it is returned to the using organization.

b. All electronic equipment testing procedures, except those for the impedance matching network for all configurations, are covered in separate technical manuals for the individual equipments (app. A). Paragraphs 4-2 through 4-4 cover the direct and general support testing procedures for the impedance matching network. Comply with the instructions preceding the body of each chart in this chapter before performing the procedures. When fully repaired impedance matching network assemblies are being tested, perform each test for the particular unit or component in the sequence given in paragraphs 4-3, and 4-4.

c. When an equipment has had minor repairs performed on it by general support maintenance teams operating within a depot (or operating under depot supervision) and is to be returned to the user instead of the Army supply stocks, deviations from the testing procedures may occur if—

(1) The deviation does not result in a lower performance standard.

(2) The specific deviations are approved by the quality assurance officer of the applicable depot.

d. The performance standards listed in the tests assume that all pertinent modification work orders have been performed. Check the current issue of DA Pam 310-7 to find the latest listing of modification work orders of the equipment under test.

4-2. Test Equipment, Tools and Materials Required

All test equipment, tools, and materials required to perform the testing procedures in this chapter are listed below.

a. Test Equipment and Materials. Multimeter AN/URM-105 and Varnish Corrosion and Fungus Resistant MIL-V-173 are the only test equipment and materials required.

b. Tools. All tools required are contained in Tool Kit, Radio Repair TK-100/G.

4-3. Physical Tests and Inspection

a. Test Equipment and Materials. None.

b. Test Connections and Conditions. Impedance matching network removed from impedance matching support P/N 209-075-236. Refer to TM 11-1520-221-20.

c. Procedure (fig. 2-3 and 2-3.1).

Step No.	Test Procedure	Performance standard
1	a. Inspect board for cracks and damage	a. No damage is evident.
	b. Inspect protective coating for chips and cracks	b. Protective coating covers all components; no damage is evident.
	c. Inspect printed circuitry for damage	c. No damage is evident.
2	a. Inspect resistors, capacitors, and diodes for faulty solder connections and damage.	a. All solder connections appear secure and no damage is evident.
	b. Inspect relays for secure mounting and evidence of broken leads and damage.	b. All mountings secure and no evidence of broken leads or damage.

4-4. Impedance Matching Network (P/N 209-075-235), Component Tests

a. Test Equipment and Materials.

(1) Multimeter AN/URM-105.

(2) Varnish, Corrosion and Fungus Resistant MIL-V-173.

b. Test Connections (fig. 2-3 and 2-3.1).

Connect Multimeter AN/URM-105 leads to the leads on the components.

NOTE

To permit good electrical contact prior to checking each individual resistor, capacitor, or diode, scrape off varnish coating where test leads are to be connected. After checking the components, brush-apply two coats of varnish on the area in which varnish was removed.

Step No.	Test Procedure	Performance standard
1	Check R9	73 to 86 ohms
2	Check R10	95 to 105 ohms
3	Check R11	95 to 105 ohms
4	Check R12	95 to 105 ohms
5	Check R13	142 to 158 ohms
6	Check R14	65 to 71 ohms
7	Check R15	95 to 105 ohms
8	Check R16	95 to 105 ohms
9	Check R17	95 to 105 ohms
10	Check R18	171 to 189 ohms
11	Check R19	371 to 409 ohms
12	Check R20	142 to 158 ohms
13	Check R21	142 to 158 ohms
14	Check R22	37 to 41 ohms
15	Check R23	114 to 126 ohms
16	Check R24	114 to 126 ohms
17	Check R25	78 to 86 ohms
18	Check R26 (A, B, and C)	314 to 347 ohms
19	Check R26 (D)	285 to 315 ohms
20	Check R27 (A, B, and C)	209 to 231 ohms
21	Check R27 (D)	285 to 315 ohms
22	*a.* Check C5	*a.* Quick pointer deflection to near zero scale, then gradual (4 seconds) return to infinity.
	b. Reverse polarity and observe deflection again	*b.* Same as *a.*
23	*a.* Check CR5	*a.* Forward resistance 100 ohms
	b. Reverse leads to CR5	*b.* Reverse resistance 3 megohms
24	*a.* Check CR6	*a.* Same as 21a
	b. Reverse leads on CR6	*b.* Same as 21b
25	*a.* Check CR7	*a.* Same as 21a
	b. Reverse leads on CR7	*b.* Same as 21b
26	*a.* Check CR8	*a.* Same as 21a
	b. Reverse leads on CR8	*b.* Same as 21b
27	*a.* Check CR9	*a.* Same as 21a
	b. Reverse leads on CR9	*b.* Same as 21b
28	*a.* Check CR10	*a.* Same as 21a
	b. Reverse leads on CR10	*b.* Same as 21b
29	*a.* Check CR11	*a.* Same as 21a
	b. Reverse leads on CR11	*b.* Same as 21b
30	*a.* Check CR12	*a.* Same as 21a
	g. Reverse leads on CR12	*b.* Same as 21b
31	*a.* Check CR13	*a.* Same as 21a
	b. Reverse leads on CR13	*b.* Same as 21b
32	*a.* Check CR14	*a.* Same as 21a
	b. Reverse leads on CR14	*b.* Same as 21b
33	*a.* Check CR15	*a.* Same as 21a
	b. Reverse leads on CR15	*b.* Same as 21b
34	*a.* Check CR16	*a.* Same as 21a
	b. Reverse leads on CR16	*b.* Same as 21b

4-5. Testing Procedures, IFF System – AN/APX-72.

a. Purpose of External Test Equipment for IFF Set. The AN/APM-123(V)1 transponder test set (figure 4-1) is used to provide a coded radio frequency (rf) interrogation signal to check the transponder set receiver and decoder and, in addition, check the transponder set transmitter and coder by evaluating the coded rf replies. The test set can be directly coupled to the transponder antenna system utilizing the antenna test hood MX-4396/APM-123(V) in conjunction with the 55db attenuator. (See figure 4-2.)

CAUTION

Failure to use the 55db attenuator will seriously damage the AN/APM-123(V)1 transponder test set.

b. Preliminary Test Setup.

(1) Visually inspect the IFF set installation for defects or damage.

(2) Install antenna test hood MX-4396/APM-123(V) over AT-884( )/APX antenna in accordance with TM 11-6625-667-12.

(3) After the couple to the antenna is made, connect the AN/APM-123(V)1 to either a 28V DC or 115V AC power source.

(4) Connect external power 27V DC to external power receptacle of helicopter.

(5) Close appropriate circuit breakers; energize the AN/APX-72 by setting MASTER switch to STBY and the AN/APM-123(V)1 by setting the 28V DC-OFF-115V AC switch to the selected power. Allow approximately 10 minutes for the equipment to warm up. Perform the following tests.

c. Testing – Mode 1 Checks.

(1) Set the controls on the AN/APM-123(V)1 as follows:

FUNCTION switch	SYSTEM
MODE	1
CODE dials	0000
ISLS	OFF

(2) Set the controls on the control unit C-6280A(P)/APX as follows:

MASTER switch	STBY (for 3 minutes) then NORM
IDENT switch	OUT
M-1 switch	ON
M-2, M-3/A and M-C switches	OUT
MODE 1 code dials	00
MODE 2 code dials (on transponder)	0000
MODE 3 code dials	0000
MODE 4 ON-OUT switch	OUT
AUDIO-OUT-LIGHT switch	OUT
CODE selector (Mode 4)	ZERO

(3) Press the PUSH TO TEST switch on the AN/APM-123(V)1 test set. The ACCEPT light should illuminate.

(4) Change CODE dials on both AN/APM-123(V)1 and C-6280A(P)/APX to 73.

(5) Press the PUSH TO TEST switch on the AN/APM-123(V)1. The accept light should illuminate.

d. Testing – Modes 2, 3/A and TEST Checks. Repeat above steps c (1) through c (5) for modes 2 and 3/A and TEST using 0000 and 7777 codes for each mode. Mode 2 codes are selected on the code dials on the RT unit. When checking the TEST mode, hold RAD TEST-OUT-MON switch in the RAD TEST position.

NOTE

On the transponder set control, the two code selector MODE 1 wheels correspond to codes A and B on the test set and the four code selector wheels for modes 2 and 3/A correspond to codes A, B, C and D on the test set.

e. Testing – Mode C Checks (When Altimeter-Encoder AAU-21/A is Installed).

(1) Place the C-6280A(P)/APX M-C switch to ON and the other mode switches to OUT.

(2) Place the AN/APM-123(V)1 MODE switch to C.

(3) Set 29.92 inches of Hg. in the barometric pressure (in Hg) window on the front of AAU-21/A Altimeter-Encoder by turning the barometric zero setting knob.

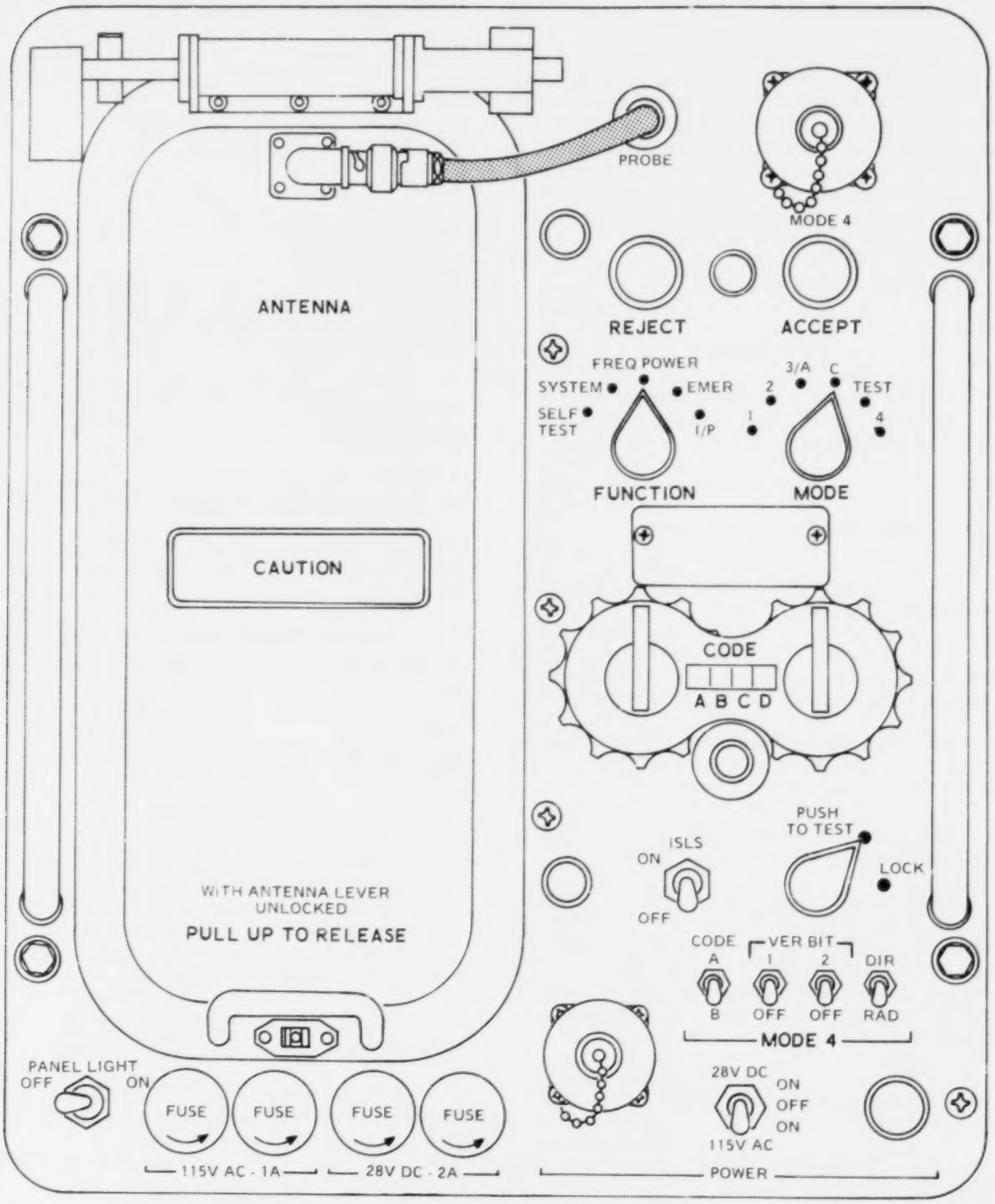

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Figure 4-1. Transponder Test Set AN/APM-123(V)1

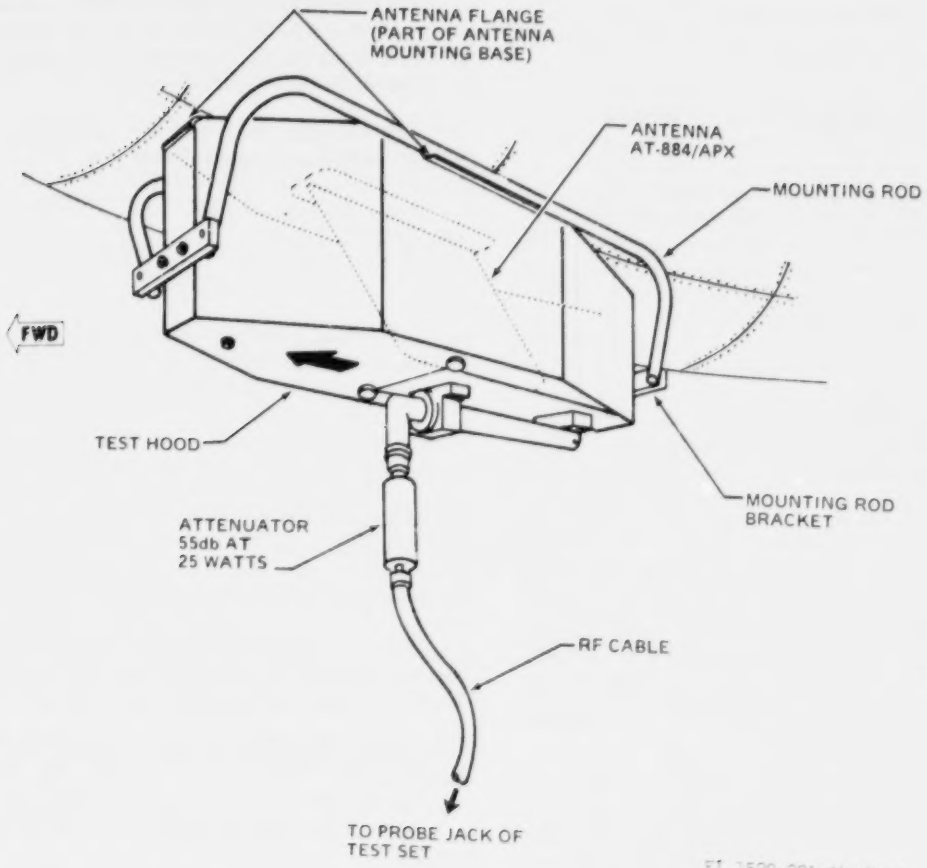

Figure 4-2. Antenna Test Hood MX-4396/APM-123(V) Installation.

(4) Observe the Altimeter-Encoder pointer indication and set the corresponding reply code into the AN/APM-123(V) as shown in the following chart:

Altimeter-Encoder, AAU-21/A Pointer Indication (feet)	Reply code to be set into AN/APM-123(V)1
-200	0640
-100	0660
000	0620
100	0630
200	0610
300	0210
400	0230
500	0220
600	0260
700	0240
800	0340
900	0360

If the pointer indication is 100 feet, then the proper code for the test should be 0630.

NOTE

If the indicated altitude is between two of those listed above, use the nearest altitude and corresponding code. Because the altimeter-encoder tolerance is plus or minus 40 feet, it may be necessary to use the other altitude and corresponding code.

(5) Depress the AN/APN-123(V)1 PRESS TO TEST switch. The ACCEPT light should illuminate.

f. Testing – Emergency Checks.

NOTE

Confine the EMERGENCY position and codes 7600 or 7700 in either modes 2 or 3/A to closed loop testing. Code 7600 signifies a communications failure and code 7700 signified an aircraft in distress.

(1) Set the controls on the C-6280A(P)/APX as follows:

M-1, M-2, M-3/A	Optional
MODE 1 code dials	00
MODE 2 code dials (on transponder)	0000
MODE 3A code dials	Optional
MASTER switch	EMER

(2) On the AN/APM-123(V)1, set the FUNCTION switch to EMER and press the PUSH TO TEST switch. The ACCEPT light should illuminate with the AN/APM-123(V)1 MODE switch in position 1 and 2 when the AN/APM-123(V)1 CODE dials match those of the C-6280A(P)/APX.

(3) Repeat step (2) with the AN/APM-123(V)1 MODE switch set to 3/A and the CODE dials set to 7700. The ACCEPT light shall illuminate regardless of the setting of the C-6280A(P)/APX CODE dials.

g. Testing – IDENT Checks.

(1) Set the controls on the C-6280A(P)/APX as follows:

M-1, M-2, and M-3/A	ON
MODE 1 code dials	00
MODE 2 code (on transponder)	0000
MODE 3/A code dials	0000
MASTER switch	NORM

(2) Set the controls on the AN/APM-123(V)1 as follows:

FUNCTION switch	I/P
MODE switch	1
PUSH TO TEST switch	LOCK
CODE dials	0000

(3) On the C-6280A(P)/APX, momentarily set the INDENT-OUT-MIC switch to IDENT. The ACCEPT light should illuminate for a period of 15 to 30 seconds.

(4) Repeat step (3) for AN/APM-123(V)1 MODE switch settings of 2 and 3/A.

(5) Release PUSH TO TEST switch on AN/APM-123(V)1.

NOTE

The MIC position of the IDENT switch is disabled; therefore, not checks are required in the MIC position of the IDENT switch.

h. Testing – Mode 4 Checks.

(1) Connect Interrogator Computer KIR-1A/TSEC to test set MODE 4 connector using cable CX-12216/APM-123(V). ZEROIZE light on the test set should light.

(2) Using Code Changer Key KIK-18/TSEC, key the KIR-1A and close the access door. XEROIZE light on the test set should go out.

(3) Install Computer KIT-1A/TSEC in the aircraft.

(4) Connect headset to aircraft intercom system.

(5) Set the controls on the C-6280A(P)/APX as follows:

Control	Position
MASTER	NORM
TEST M-1/OUT	OUT
TEST M-2/OUT	OUT
TEST M-3/OUT	OUT
TEST MC/OUT	OUT
AUDIO/OUT/LIGHT	AUDIO
CODE	A
MODE 4 ON/OUT	OUT

(6) On the AN/APM-123(V)1 test set, place the FUNCTION Switch to SYSTEM, the MODE 4 DIR/RAD Switch to DIR, the MODE Switch to 4, the MODE 4 Code A/B Switch to A and the PUSH TO TEST switch to the lock position, and when operating test set observe the following:

(a) On the test set, the REJECT light should light.

(b) Audio tone should be heard in headset.

(c) IFF CAUTION light should light.

(7) Using KIK-18/TSEC, key the KIT-1A/TSEC and close access door. Observe same indications listed in (6) above. Release PUSH TO TEST Switch.

(8) On C-6280A(P)/APX, place the MODE 4 switch to ON.

(9) On the AN/APM-123(V)1 test set, briefly depress the PUSH TO TEST Switch to observe the following:

(a) On the test set, the ACCEPT light should light.

(b) On the C-6280A(P)/APX, the REPLY light should light.

(c) Audio tone should be heard in headset.

(d) Aircraft IFF CAUTION light should be OFF.

(10) On the C-6280A(P)/APX place the AUDIO/LIGHT switch to the LIGHT position, and repeat the above test. Audio tone should not be heard, but REPLY light should light.

(11) On the test set, place the MODE 4 CODE A/B switch to B and briefly depress the PUSH TO TEST switch. The REJECT light should light. Return MODE 4 CODE A/B Switch to A.

(12) On the test set, place the MODE 4 VER BIT 1 switch to 1 and briefly depress the PUGH TO TEST switch. The REJECT light should light. Return MODE 4 VER BIT 1 switch to OFF.

(13) On the test set, place the MODE 4 VER BIT 2 switch to 2 and briefly depress the PUSH TO TEST switch. The REJECT light should light. Return MODE 4 VER BIT 2 switch to OFF.

(14) On the test set, place the ISLS switch to ON and briefly depress PUSH TO TEST switch. The REJECT light should light. Return ISLS switch to OFF.

(15) Set IFF CODE HOLD switch located on aircraft instrument panel to ON. IFF CODE HOLD light located on aircraft instrument panel should light.

(16) On C-6280A(P)/APX, place CODE switch to HOLD, then return to A.

(17) Wait at least 15 seconds and then on the C-6280A(P)/APX turn MASTER switch to OFF.

(18) Wait at least 15 seconds and then on the C-6280A(P)/APX turn MASTER switch to STBY for a warmup of about 30 seconds, then turn MASTER Switch to PUSH

(19) On the test set, briefly depress PUSH TO TEST switch. ACCEPT light should light.

(20) On the C-6280A(P)/APX pull out CODE switch and turn to ZERO, and place AUDIO/LIGHT switch to AUDIO position.

(21) On the test set, place PUSH TO TEST switch to LOCK position, and observe the following:

(a) On the test set the REJECT light should light.

(b) Audio tone should be heard to headset.

(c) IFF CAUTION light should light.

i. Test Procedure Using the TS-1843/APX.

(1) Set the controls on the C-6280A(P)/APX as follows:

MASTER switch	NORM
IDENT	OUT
MODES 1, 2, 3/A & C	ON
MODE 1 CODE	Any code
MODE 2 CODE (on transponder)	Any code
MODE 3/A CODE	Any code
RAD TEST-OUT-MON	OUT

(2) Place M-1 switch on the C-6280A(P)/APX in the TEST position.

(3) The green TEST light on the C-6280A(P)/APX should illuminate, indicating the following conditions exist:

(a) The TS-1843 has initiated an interrogation of power MODE 1 signals.

(b) The RT-859/APX-72 has recognized the interrogation and transmitted reply.

(c) The TS-1843 has evaluated the reply and is satisfied that the frequency (1090 plus or minus 3.0 MHz), the power (20 to 28 DBW), the bracket pulse spacing (20.3 plus or minus 0.15 μsec.) and the antenna VSWR (8 plus or minus 2.5 db or less) are within specified limits.

(4) Repeat steps (a), (b), and (c) above for MODES 2, 3/A and C.

(5) Place FUNCTION selector in SYSTEM position.

(6) Place RAD TEST-OUT-MON switch in MON position, repeat Mode 1 checks in above steps c (1) through c (5), and observe that the test light glows whenever the ACCEPT indicator remains illuminated on the AN/APM-123-V. Place the RAD TEST-OUT-MON switch in RAD TEST position and note that the TEST light does not illuminate. This demonstrates that the TEST light on the C-6280A(P)/APX will not illuminate when being interrogated in the TEST mode if the RAD TEST-OUT-MON switch is in RAD TEST position.

NOTE

The TEST light may blink out momentarily at a slow steady rate while in MON. This is normal and does not indicate a failure. No light or a random flickering light shall indicate a failure.

When not conducting a MON check for an extended period of time return RAD TEST-OUT-MON switch to OUT Position.

(7) Remove electrical power from the IFF Set.

CHAPTER 5

STABILITY AND CONTROL AUGMENTATION SYSTEM (SCAS)

Section I. INTRODUCTION

5-1. Scope

a. The following information is required for maintenance of the Model 570A Stability and Control Augmentation System (SCAS) installed in the Army Model AH-1G Helicopter. It includes appropriate instructions for testing and troubleshooting the electronic components SCAS Control Panel P/N 570-074-060 and Sensor Amplifier Unit P/N 570-074-010 when the equipment is installed in the helicopter. It lists tools, test equipment, and materials required by maintenance personnel to maintain, test, align, and adjust the stability augmentation system. Also included are instructions required for performing troubleshooting and bench or shop testing and maintenance of the SCAS Control Panel Sensor Amplifier Unit, and Pylon Compensation Unit P/N 570-074-131.

b. A detailed description of the SCAS is contained in TM 11-1520-221-20.

c. Analysis of the SCAS circuits is covered in section II. Detailed circuit analysis of the Control Panel and the Sensor Amplifier Unit are also covered in section II.

d. Operational checks, troubleshooting charts, and procedures are included in section III. The charts include functional checks, normal reactions, and procedures to aid maintenance personnel to properly repair and service the SCAS electronic equipment.

e. Section IV contains specific bench tests and performance criteria for new or repaired SCAS electronic equipment.

5-2. Technical Characteristics of the SCAS Augmentation System

a. SCAS Voltage Requirements.

Direct current	4.5 amps at 27.5 +2 volts dc.
Alternating current	35 VA at 115 volts ac, single phase.

b. SCAS Hydraulic Power Requirements.

Each servo actuator	0.5 gpm maximum at 1500 psi.

c. SCAS Control Panel, BHC.

Voltage requirements	27.5 volts dc ±2. 115 volts ac ±11.5, 380 to 420 Hz.
Indicators:	
NO GO lights	System disability warning indicators.
Output:	
Engage	To solenoid valves.
Power	Ac and dc power to system.

d. Sensor Amplifier Unit.

Voltage requirements	27.5 ±2 volts dc (regulated to 20 volts dc for control transducers). 115 volts ac ±11.5, 380 to 420 Hz (stepped down to 26 volts internally for transducers).
Input signals	Servo actuator position feedback, aircraft rates. Aircraft control positions.
Output signals	To servo actuators.

e. Control Motion Transducer.

Voltage requirement	20 volts dc (from sensor amplifier unit).
Output signal	Control position, to sensor amplifier unit.
Voltage requirement	20 volts dc (from pylon compensation unit).
Output signal	Pylon position to pylon compensation unit.

f. Servo Actuator.

Voltage requirement	26 volts ac, 380 to 420 Hz (from sensor amplifier unit).
Input signal	Control error signal.
Torque motor:	
Coil	2000 ±200 ohms.
Current	±5 ma maximum.
Output signal	Actuator position.

g. Solenoid Valve.

Voltage requirement	+27.5 ±2 volts dc.

h. Pylon Compensation Unit.

Current	0.25 amps. 27.5 ±2 vdc.
Output signal	Compensation pylon motion signal (to sensor amplifier unit.

Section II. CIRCUIT ANALYSIS

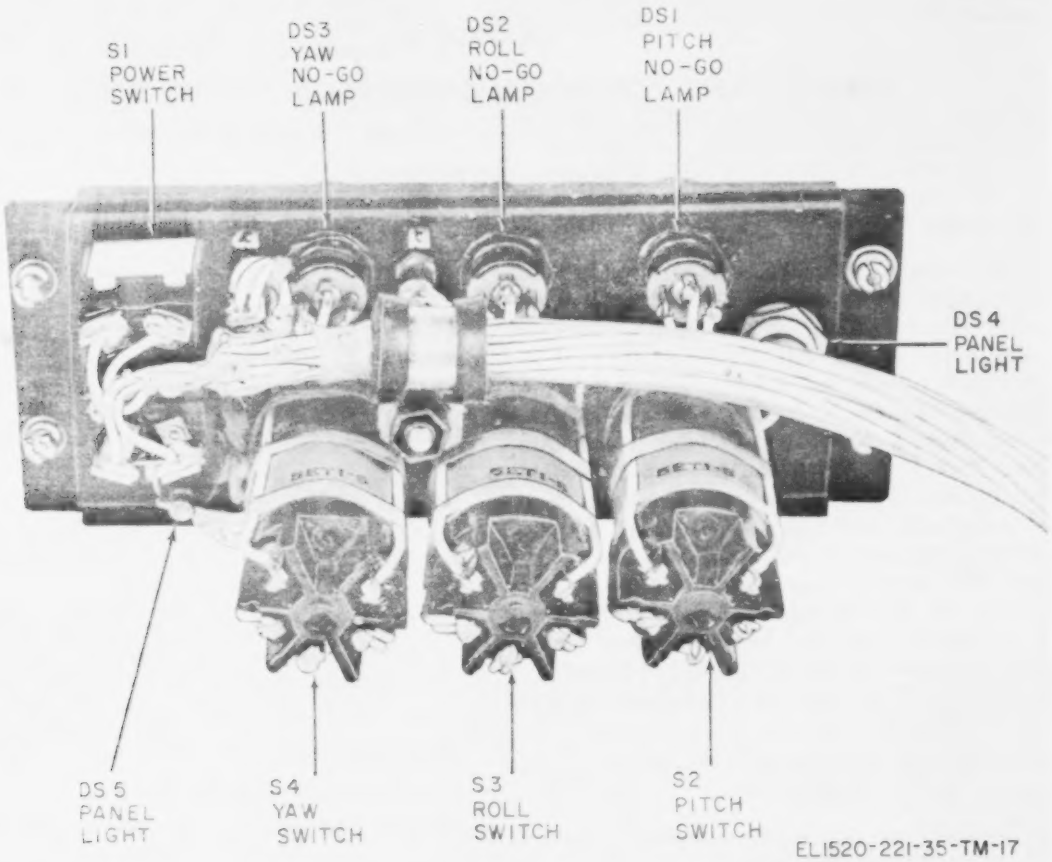

Figure 5-1. SCAS control panel, rear view.

5-3. Introduction to Functioning Discussions

The purpose, operation, and interoperation of the various circuits used in the system are explained in this section. Familiarity with the system (fig. FO-13 and FO-14) and the individual electronic components (how they work and why they work that way) is important in troubleshooting and maintaining the system and the individual electronic components. For parts location refer to figures 5-1 through 5-5.

5-4. Power Circuits (fig. FO-14)

a. Dc Power Circuits. The Model 570 SCAS receives 28 volts dc from the pilot's dc circuit breaker panel through the 5-ampere SAS CONT circuit breaker. With dc power on the circuit breaker closed, 28 volts dc is connected through pin U of the control panel connector 2J1 to one side of the SAS POWER switch S1, then through S1 to terminal E2 in the control panel, where it is distributed to pins S, C, E, and N of 2J1, and to DS1, DS2, and DS3 NO GO indicator lights. From pins S, E, and C of 2J1 dc power is applied to the pitch, roll, and yaw solenoid valves respectively through pins A of connectors J703/P703, J702/P702, and J701/P701. Dc power is applied to the S2 (PITCH), S3 (ROLL), and S4 (YAW) engage switch holding coils through pin h of the sensor amplifier unit connector 1J1, through the protective fuse F1, through pin 5 of 1J6, and then through the contacts of the ac innerlock relay K1 through pin 2 of 1J6 and pin g of 1J1 and pin M of 2J1 to pin 4 on S2, S3, and S4 from pin N of 2J1.

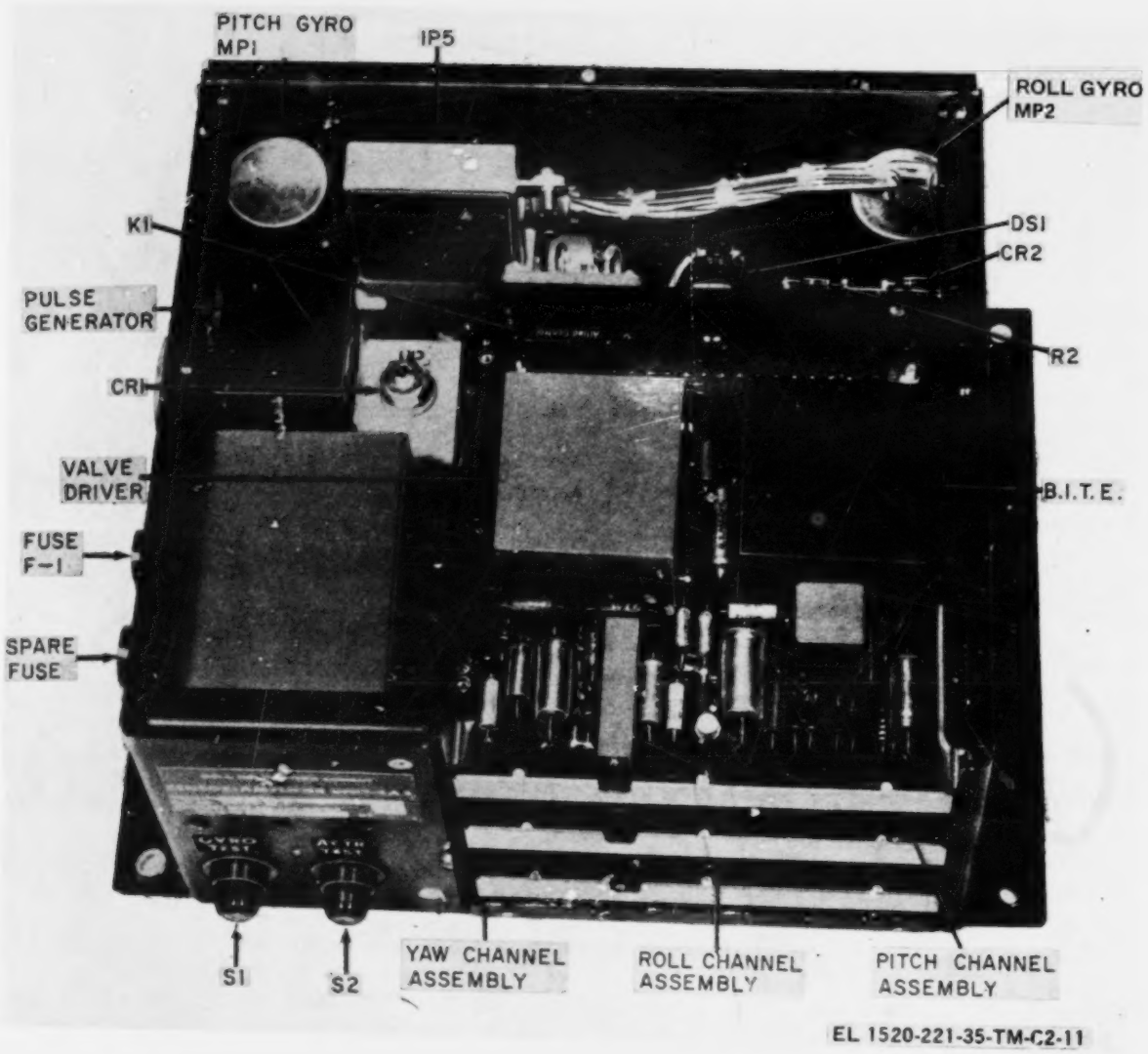

Figure 5-2. SCAS Sensor amplifier unit, front view.

The S2, S3, and S4 holding coil ground is provided from pin 5 of S2, S3, and S4 to ground terminal E1 through pin P of 2J1, pin U of J34, through the normally closed contacts of emergency disengage switch S41 (pilot's cyclic stick grip), through pin V of J34, through pin U of J91, through the normally closed contacts of emergency disengage switch S44 (gunner's cyclic stick grip), through pin V of J91, and through pin H of 2J1. F1 also distributes 28 volts dc to R1 and to pins D of connectors 1J4, 1J3, and 1J2. From pin D of the above connectors, dc power is furnished to pins 2 and 9 of the Built-In Test Equipment (B.I.T.E.) module, pin 9 of the VALVE DRIVE module, and the positive side of C3. Dc power is supplied from pin D of 1J4 to the inductor L1 for filtering. The filtered dc is then distributed to pins S of 1J4, 1J3 and 1J2 from pins 3, 2, and 1 of L1 respectively. Filtered dc is supplied from pins S of 1P4, 1P3, and 1P2, to the positive side of C1, R17, R6, and pin 5 of valve driver module.

b. Ac Power Circuits. The SCAS receives 115 volts ac through the 1-ampere SCAS PWR circuit breaker. With ac power on and the circuit breaker closed, 115 volts ac is connected through pin T of connector 2J1 to the control panel POWER switch S1. Ac power is applied through S1

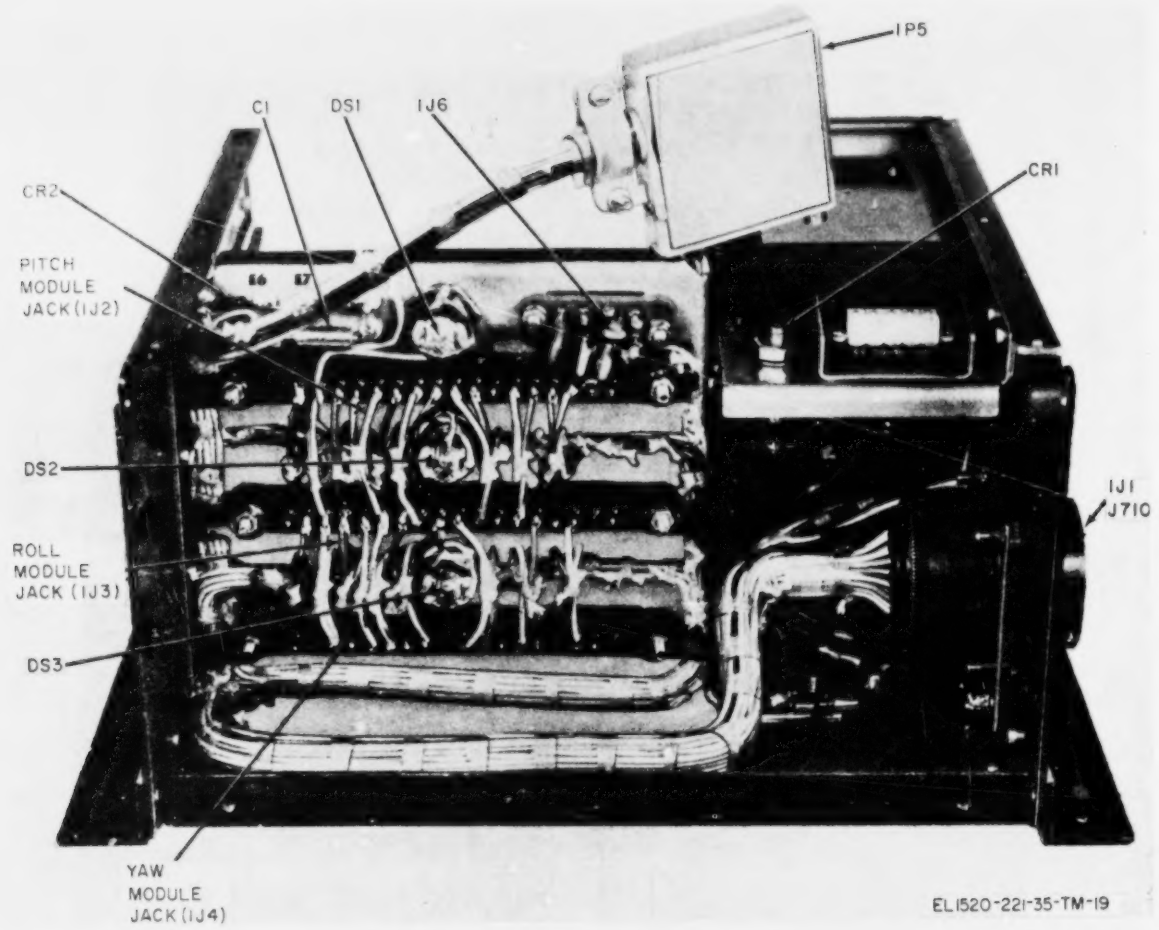

Figure 5-3. SCAS Sensor amplifier unit, rear view.

and pin V of 2J1 connector to pin R of 1J1 connector. From pin R of 1J1, ac power is applied to pin 3 of the AC power module A1 and to the 115v pin of the pulse generator module A2. The 26-volt ac two-phase power output of A1 is applied to each rate gyro spin motor; pins 1 and 5 of MP1 (Pitch), MP2 (Roll), and MP3 (Yaw) through pins S and N (Pitch), L and H (Roll), and M and J (Yaw) of 1J5 from pins 7, 6, 2, and 4 of A1. In-phase 26 volts ac is supplied from pin 4 of A1 to the anode of CR2 and pin 2 of S2. In-phase 26 volts ac power is applied to pin A of the control tube assemblies Z2, Z3, and Z4 through pins B, C, and Y respectively of connector 1J1 for excitation of the feedback transducers located in the actuators.

c. Regulated Dc Circuits. A regulated 20 volts dc is furnished by CR1 and is applied to B+ of the pulse generator module A2. The 20 volts dc is also applied to pitch (MT1), roll (MT2), and yaw (MT3) control motion transducers through pins a, r, and t of 1J1, and through pin C of connector J704 and J706 for pitch and yaw and through pin A of J705 and J706 for roll and yaw.

5-5. Pilot's Control Signal Circuit

The maximum swing of the control signal is 20 volts dc, and this magnitude can be reduced if necessary to achieve the desired gains by increasing the value of R2. The pilot's control signals from each individual channel are inserted into the sensor amplifier unit at pins p, c, and N of 1J1 through pin B of connectors J704, J705, and J706. From pins p, c, and n of 1J1 the control signal for each individual axis is

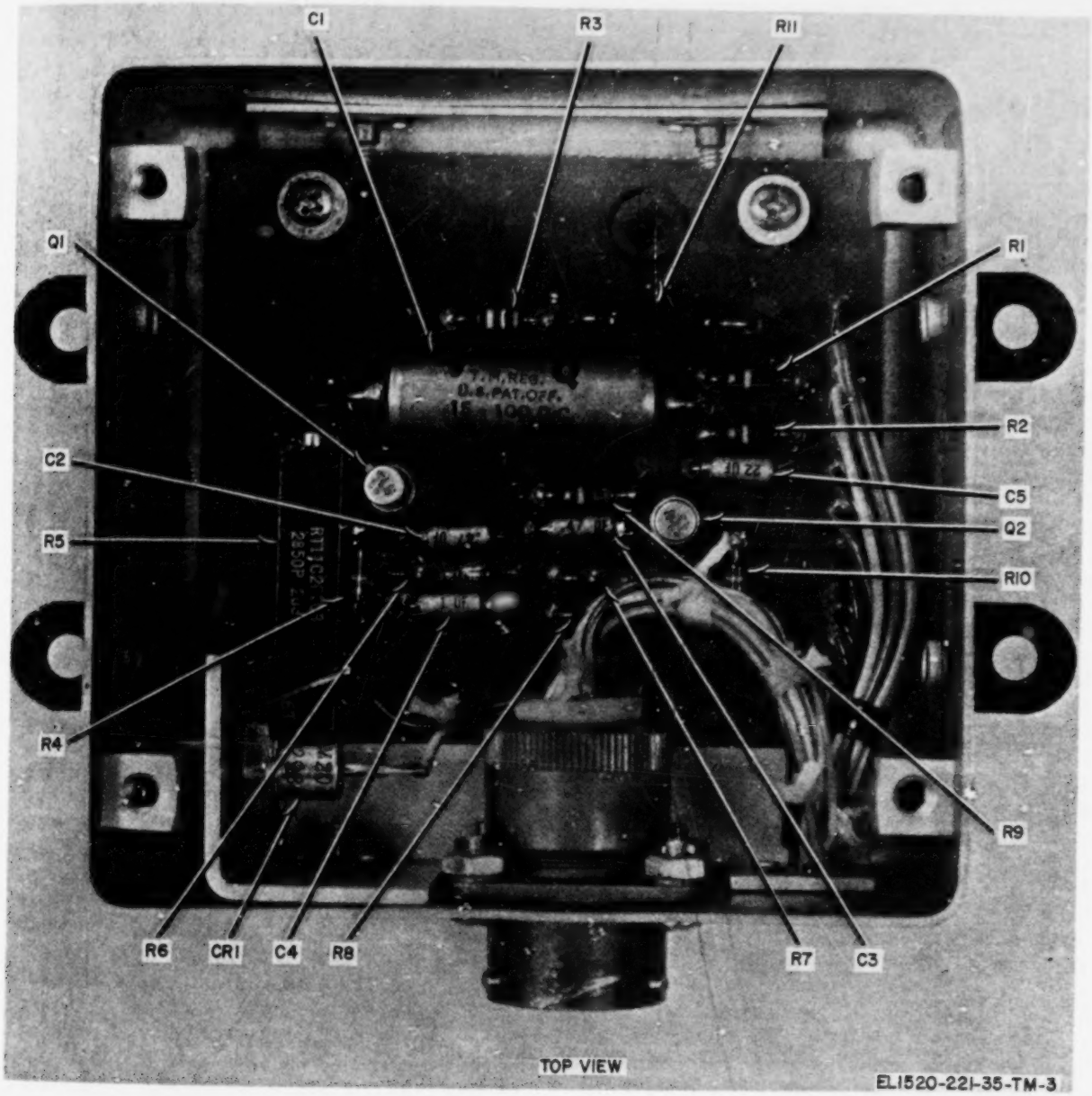

Figure 5-4. Pylon compensation unit, top view.

distributed to pin M of 1J4, 1P3, and 1J2 for the corresponding channel. From pin M, the control signal is shaped for each transfer function which is required in pitch, roll, and yaw. Each transfer function is obtained by R12, C4, R15, R16, C5, C6, and R20 (fig. 5-4 and 5-5). Resistor-capacitor combination R12 and C4 form a pilot's signal lag circuit. Resistors R15 and R16, in addition to providing a summing circuit for the pilot's signal and the rate gyro signal, are used in parallel to form a signal lag circuit with capacitor C5. Transformer T1 and R17, C5, CR3, CR4, CR5, and CR6 serve as a demodulation circuit for the rate gyro signal and do not materially affect the pilot's signal except for an enlarging effect on C5. The control signal is then applied to the base of emitter follower stage Q1. Collector bias is furnished to Q1 by CR1 in the

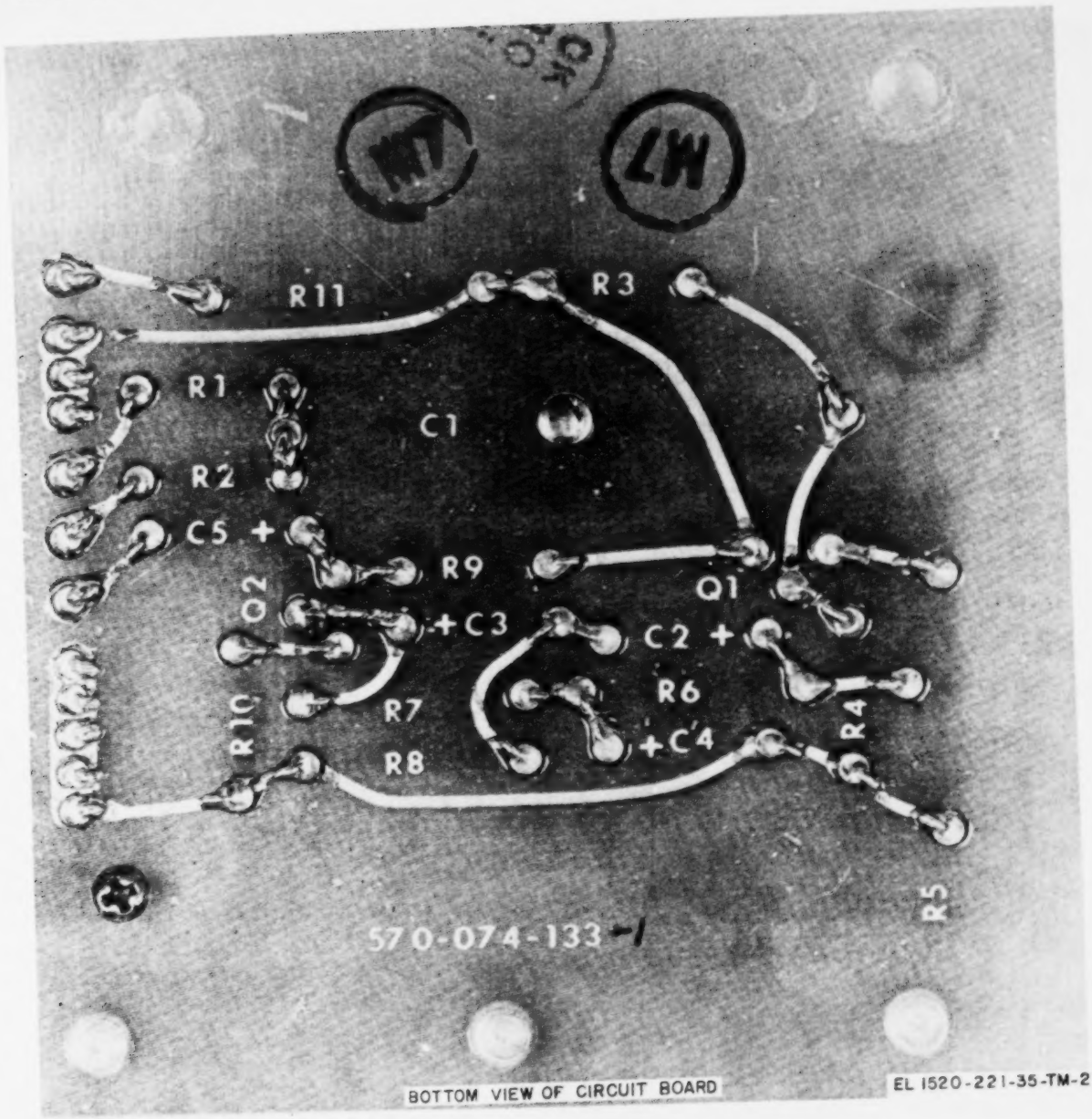

Figure 5-5. Pylon compensation unit, bottom view.

form of 20 volt regulated dc. R19 is the emitter resistor for Q1. Upon leaving the emitter of Q1, the control signal passes through a lead circuit in the form of C6 and R20, which is referred to as the washout circuit. R20, in addition to being a part of the washout circuit, is the signal mixing resistor which applies the control signal to the input of the valve driver amplifier at pin 6. The gain of each channel is set by the choice of R20. In pitch and roll only, a small amount of pilot lead is also obtained by resistor-capacitor combination R14, C2. The control signal is now amplified through the valve driver module A2 and is applied to the actuators Z2, Z3, and Z1 from pins 1 and 10 of the valve driver modules A2 through pins E and T of connector 1J2, 1J3, and 1J4; through pins f and q, b and e and L and M of 1J1, and finally through pins E and F of P707, P708, and P709 for pitch, roll, and yaw respectively.

5-6. Ac Interlock Circuit

The function of this circuit is to provide automatic disengagement for the SCAS in case the 115 volts ac fails. Control panel switches S2, S3, and S4 open automatically when 28 volts dc is removed from their coils. Therefore, by energizing the relay coil of K1 with rectified dc from the 115-volt ac source, the main 28 volts dc through the closed contacts of K1 to S2, S3, and S4 can be interrupted and the system will disengage in case of ac power failure. This auxiliary dc supply for the coil of K1 is derived from the ac supply through the one-half wave rectifier CR2, dropping resistor R2, and filter capacitor C1.

5-7. Solenoid Valve Control Circuit

The solenoid-operated hydraulic valve in each channel is normally closed and opens only when 28 volts dc is applied between pins A and B of connectors J701, J702, and J703. These valves are used to furnish hydraulic pressure to the hydraulic actuators Z2, Z3, and Z4. The 28 volts dc is supplied to pins A of P701, P702, and P703 through pins S, E, and C of 2J1 from S1 Pins B of the solenoid valves are connected to ground by S2, S3, and S4 through pins q, b, and c of 2J1 of the control head.

5-8. Built-In Test Equipment (B.I.T.E.) Module Circuit

One B.I.T.E. module is used in each channel of the SCAS to energize the NO GO lights. If the ac pulse at terminal 10 of the valve driver module A2 exceeds 6 ±2 volts higher or lower than the valve driver module bias level at pin 10 because of a malfunction or warmup time, the NO GO lights come on. If the pulse level at pin 10 of the valve driver module A2 exceeds its specified limits, the pulse being fed through R7 and R8 to pin 1 of the B.I.T.E. module will cause A1 to present 28 volts dc at pin 8 to energize the NO GO light for that channel. The NO GO lights DS1, DS2, DS3 in the sensor amplifier unit receive 28 volts from pin 8 of the B.I.T.E. module through pins C of connectors 1J2, 1J3, and 1J4. The NO GO lights on the control panel receive power applied to pin 2 from pin 8 of B.I.T.E. module through pins C of connectors 1J2, 1J3, and 1J4 through pins n, d, and P of 1J1; through pins R, D, and F of 2J1. The B.I.T.E. module receives 28 volts dc on pin 9. Pin 6 is ground for this module.

5-9. Pulse Generator Module Circuit (fig. FO-14)

One pulse generator module A2 is required for each SCAS. A2 receives 20 volts dc from CR1 on pin designated B+, 115 volts ac on pin designated 115V, and ground on pin designated GRD. A2 furnishes two separate pulse outputs, one positive going and the other negative going. One output, the positive pulse appearing at pins pp is applied through pin H of connector 1J2, 1J3, and 1J4 to pin 3 of the valve driver module for gating of the input. The other output of the pulse generator module A2, the negative pulse, appears at pin NP and is applied to pin 4 of the transformer T1 through pin F of connector 1J2, 1J3, and 1J4 to synchronize the demodulator in the compensating circuit to 400 Hz. The negative pulse is also applied through pin F of connectors 1J2, 1J3, and 1J4 to pin 2 of the valve driver module A2 to gate this module in synchronism with 400 Hz.

5-10. Valve Driver Module Circuit (fig. FO-14)

Valve driver module A2 furnishes current for the servo coil in the hydraulic actuators. One valve driver module A2 is required for each channel of the SCAS. This module is essentially a gated dc amplifier with two outputs; one output is the reference voltage, and the other varies in accordance with the various inputs to the valve driver module A2 from the rate gyro, pilot's control circuits, pylon compensator (roll channel only) and actuator position feedback. For zero signal input, the reference level of the output at pin 10 of the valve driver module A2 is set by the amount of regulated 20 volts dc received through RT1 from CR1, which is applied at pin 4 after being attenuated by R3 and R4. A combination of all the signals applied at pin 6 also appears at pin 10 of A2 in the form of a 0.0002-sec pulse with a repetition rate of 400 Hz. The level of this pulse, for zero signal on the input, is set at the same level as the reference output valve by the amount of 20 volts dc received through RT1 from CR1, which is applied at pin 4 of A2 after being attenuated by R5, R11, R18, and R19. R5 allows the pulse and the reference outputs at pin 10 of A2 to be balanced for minor production and aging tolerances. The other output of the valve driver module A2, pin 1, follows the level of the 0.0002-sec pulse. Thus, current will flow in one direction or the other when the servo coil of the actuator is connected between pins 1 and 10 of A2, flow direction depending upon the displacement of the pulse above or below the reference. The percent of available feedback inform-

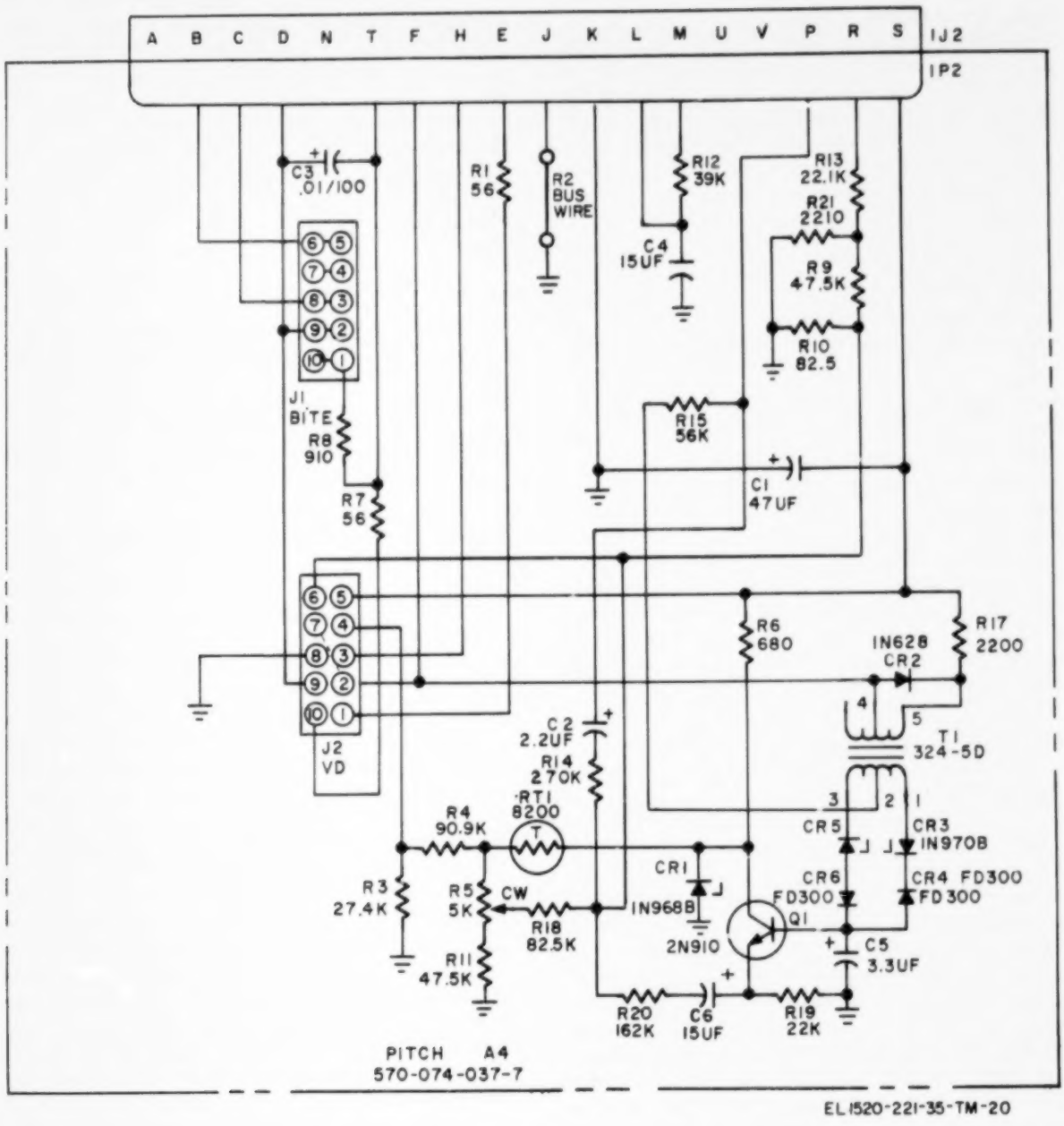

Figure 5-6. Pitch control channel assembly schematic.

ation which is received by the valve driver module A2 is determined by the attenuating network, R13 and R21. The feedback gain of the valve driver module is set by R9. RT1 and R10 are included to insure thermal stability of the valve driver A2 outputs. Actuator servo coil current drift is the chief area of stabilization affected by temperature variations. When 28 volts dc is applied to pin 9 of A2 with pin 8 of A2 being ground, filtered 28 volts dc from the ac power module A1 is applied at pin 5 of A2. The positive and negative outputs of the pulse generator A1 are applied to pins 3 and 2 of A2 respectively for gating. The reference output from the valve driver module A2 at pin 10 is applied to pin E of Z2, Z3, and pin FZ4 control tube assemblies through R7; through pin T of 1J2, 1J3, and 1J4; and through pins f, b, and L of 1J1.

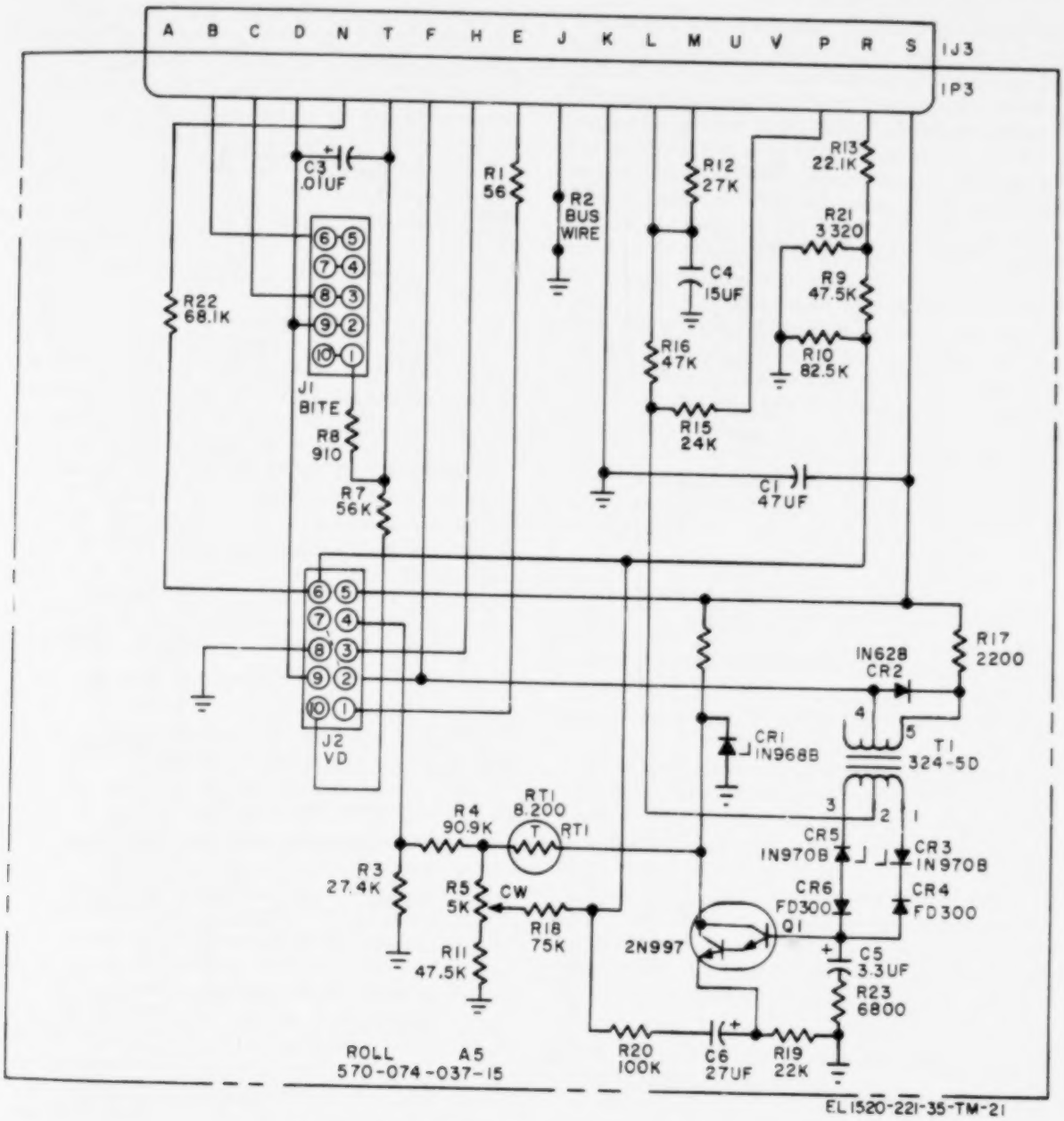

Figure 5-7. Roll control channel assembly schematic.

The reference output is also applied to pin 1 and 10 of the B.I.T.E. module J1 through R7 and R8 to activate the NO GO lights when the 0.0002-sec pulse limits exceed a certain value. C3, which is connected between 28 volts dc and pin 10 of valve driver module A2 through R7 is present for RF filtering. The output of the valve driver A2 at pin 1 of A2 is applied to pin E of Z2, and Z3, pin F of Z4 through R1; through pin E of 1J2, 1J3, and 1J4; and through pins q, e, and M of 1J1.

5-11. Rate Gyro Circuit

One rate gyro is required for each channel (pitch, roll, and yaw) to sense the various rates encountered by the helicopter in each axis. The spin motors of the gyros (MP1 pitch, MP2 roll, and MP3 yaw) require 26 volts ac two-phase for

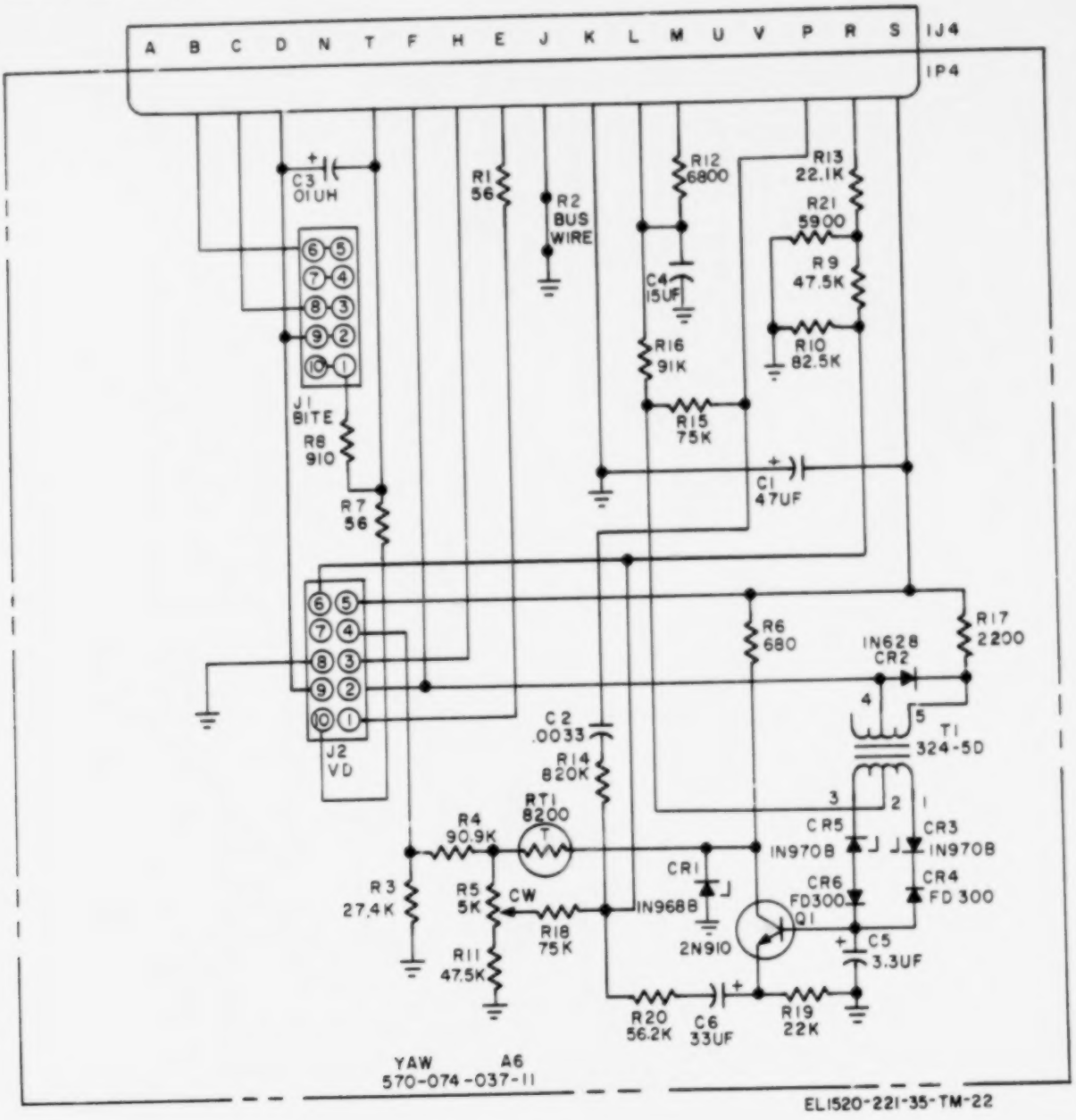

Figure 5-8. Yaw control channel assembly schematic.

operation. In addition, the output elements of the gyros are excited on pin 7 by a 5.2-volt 318-degree, 400-Hz signal from pin 5 of the ac power module A1 through the GYRO TEST switch S1 in the sensor amplifier unit and through pins K, D, and E of 1J5. The output of each individual gyro (MP1 pitch, MP2 roll, and MP3 yaw) to the appropriate control channel assembly (A4 pitch, A5 roll, and A6 yaw) is through V and X, T and P, and R and U of 1J5. The gyro signals are inserted into each control channel assembly (fig. 5-6, 5-7, and 5-8) through pins L and P of 1J2, 1J3, and 1J4. One side of the gyro output winding (pin L) is applied to R16, R12, and C4, which is essentially at ground to 400 Hz since the impedance of C4 is relatively small at that frequency. From pin P, the gyro signal is shaped for each transfer function required for pitch,

roll, and yaw. Each channel transfer function is obtained by R14, R15, R16, C2, C4, C5, C6, and R20. In addition to forming an attenuation network, resistors R15 and R16 are used in parallel with C5 to form a lag circuit for the gyro signal after it has been demodulated by the sampling circuit R17, C5, CR3, CR4, CR5, CR6, and T1. This sampling circuit, besides being a demodulating circuit, has an enlarging effect on C5. The rate gyro signal is then applied to the base of emitter follower stage Q1 and summed with any control signal which may be present. A 20-volt regulated dc collector bias is furnished to Q1 by CR1. R19 is the emitter resistor for Q1, and R6 is the series dropping resistor for CR1. Upon leaving the emitter Q1, the gyro signal passes through a lead circuit in the form of C6 and R20 which is referred to as the wash out circuit. R20, in addition to being a part of the washout circuit, is the signal mixing resistor which applies the rate gyro signal to the input of the valve driver amplifier at pin 6 of A2. The gain of each channel is set by the choice of R20. Additional lead is obtained by applying the gyro signal from pin P of 1J5 through C2 and R14 to pin 6 of the valve driver module A2.

5-12. Control Panel
(fig. 5-1)

The control panel (unit 2) contains the system POWER switch S1, three channel engage switches (S2, S3, and S4) which furnish power to the hydraulic solenoid valves (K32, K33, and K34), and the NO GO indicator lights for the pilot's checkout operation. Also contained in the control panel are two edgelights (DS4 and DS5) which are energized from the pilot's instrument panel light dimmer through pin B of 2J1 and through pin J of J8. The system POWER switch for the SCAS is a positive action switch which controls both the 28 volts dc and the 115 volts ac. The PITCH, ROLL and YAW switches are solenoid hold-in type switches which require 28 volts dc to the holding coils to remain in engaged, position. These switches are capable of being turned off or disengaged either manually or electrically. Loss of 28 volt dc or 115 volt ac or pressing of either the pilot's or gunner's emergency disengage switch (S41 or S44) located in the cyclic stick grips, will cause the engage switches to be turned off. Each time power is reapplied, the engage switches must be manually reengaged since these switches are solenoid hold-in type only.

5-13. Pilot's Emergency Disengage
(fig. FO-14)

The emergency disengage function by either the pilot or gunner is achieved by interrupting the ground circuit for the holding coil of the S2, S3, and S4 engage switches. The engage switches control dc power to the three hydraulic solenoid valves K32, K33, and K34. When dc power is removed, the solenoid valves close, removing hydraulic pressure from the three control actuators Z2, Z3, Z4. When there is no hydraulic pressure applied to the actuators, the actuators assume their neutral positions and lock, providing a mechanically rigid link in the helicopter control system. Ground for the holding coils of the engage switches in the control panel is present at pin 5 of S2, S3, and S4; through pin P of 2J1 through pin U of J34, through the emergency disengage switch on the pilot's cyclic stick grip, through pin V of J34, through pin U of J91, through the emergency disengage switch on the gunner's cyclic stick grip, through pin V of J91, and through pin H of 2J1.

5-14. Control Motion Transducer

The pilot's control movements are detected by MT1 (pitch), MT2 (roll), and MT3 (yaw) transducers. The transducers are 1K linear motion potentiometers which have 20 volts dc applied to pin C of connector J704 for pitch and to pin A of connectors J705 and J706 for roll and yaw. The pitch transducer seeks ground through pin A of connector J704; through pin K of 1J1; through J of 1J2 and through R2 to ground. The roll and yaw transducers seek ground through pin C of J705 and J706; through pins S and M of 1J1; through pin J of 1J3 and 1J4; and through R2 to ground. Signals induced by the pilot, relative to helicopter control displacements, from the transducers are supplied through pin B of connectors J704, J705, and J706.

5-15. Hydraulic Actuators and Pylon Compensation Unit

a. Hydraulic Actuators. Three hydraulic actuators are required for each SCAS. Each channel (pitch, roll, and yaw) has one actuator linked in series in the control system of the helicopter. Each actuator (pitch Z2, roll Z3, and yaw Z4) has a total travel of 0.9 inch. Each actuator contains a servo coil which is connected between pins E and F of connectors J707, J708, and J709. With pin E as a reference, this servo coil requires current of up to ±5 ma for operation. The velocity and direction of the actuators is determined from the magnitude and polarity of the servo coil current. This coil current is supplied by the valve

driver modules A2 located in the Control Channel Assembly (A4, A5 and A6) for each channel. The actuators also contain a linear variable differential transformer (LVDT) to provide position feedback information. The LVDT produces an in-phase 400 cycle signal for an extending actuator, the magnitude of which is linearly proportional to the displacement of the actuator from its neutral position. For a retracting actuator, an out-of-phase signal is produced by the feedback transducer (LVDT). The primary excitation of the feedback transducer (LVDT) is an in-phase 26-volt, 400-Hz signal from the ac power module A1 in the sensor amplifier unit which is applied to Pin A of J707, J708, and J709, with pin B of J707, J708, and J709 being grounded. From this excitation, the (LVDT) output is developed at pin D of J707, J708, and J709, with pin C of J707, J708, and J709 being grounded. The hydraulic actuators also contain a disengage feature that automatically returns the actuator to its mechanical center position and locks the actuator in its center position if hydraulic pressure is turned off or lost to the actuator. This feature assures no loss of pilot control through the mechanical controls of the helicopter.

b. Pylon Compensation Unit. The 570-074-131-1 pylon compensation unit receives 28-volts dc at pin D of J917 from pin N of P700. R11 serves as a dropping resistor for CR1 which furnishes a regulated 20-volts dc for bias on Q1 and Q2 and excitation to each pylon motion transducer.

5-16. Two-Transducer Installation

The excitation voltage is distributed through pin G, J917 to pin C, J916 to the aft transducer; through pin H, J917 to pin A, J915 to the forward transducer. The transducers seek ground through pins C, J915, and A, J916 to pins E and F, J917. The signal from the forward pylon motion transducer is inserted into the pylon compensation unit through Pin B, J915 to pin C, J917 to resistor R2. The signal from the aft transducer is inserted through Pin 5, J916 through pin B, J917 to resistor R1.

5-17. Single Transducer Installation

a. The excitation voltage is distributed through pin H, J917 through pin A, J918 to the pylon motion transducer. The transducer seeks ground through pin c, J918 to pin F, J917. The signal from the transducer is inserted into the pylon compensation unit through pin B, J918 through pin C, J917 to resistor R2.

b. Resistors R1 and R2 serve as a summing point for the transducer signals. The parallel combination of R1 and R2, C1, and R3 in parallel with R4 provide a lead term circuit for the pylon signals. Q1 and R5 serve as an emitter follower isolation stage in the network. C2, C3, C4, R6, R7, and R8 form a twin-T network which filters out 10.8 Hz. Q2, R9 and R10 form a stage of isolation and amplification. Additional lead is obtained from C5 and R22 (located in sensor-amplifier unit on 570-074-037-15 roll channel assembly).

c. The compensated signal from the pylon compensation unit is inserted through pin K, J917, through pin K, 1J1, to pin N, 1J3 in the sensor-amplifier unit. R22 serves as a mixing resistor to insert the compensated signal into the input of the valve driver module.

5-18. Gyro and Actuator Test Switches

a. Gyro Test Switch. The GYRO TEST switch, mounted on the sensor amplifier, serves to enable testing of the rate gyro. Depressing the GYRO TEST switch removes all excitation to gyro rate output transducer. If a high null exists, indicating an unbalance in the system (causing NO GO light to illuminate) pressing test switch will eliminate this problem (causing NO GO light to extinguish) thus indicating a faulty rate gyro.

b. Actuator Test Switch. The ACTR TEST switch, mounted on the sensor amplifier, serves to enable testing of the servo actuator. Depressing ACTR TEST switch removes all excitation to the actuator feedback transducer. If a high null exists, indicating an unbalance in the system (causing NO GO light to illuminate) pressing test switch will eliminate this problem (causing NO GO light to extinguish) thus indicating a faulty servo actuator.

Section III. MAINTENANCE TECHNIQUES

5-19. General Instructions

The systematic maintenance procedures begin with the functional operation and sectionalization checks that can be performed in the helicopter and they continue with the bench testing and maintenance of the individual electronic components.

5-20. Organization of Troubleshooting Procedures

a. General. Troubleshooting the stability and control augmentation system (SCAS) in AH-1G and AH-1Q helicopters is performed in three steps. The first step, sectionalization, is to trace the fault to a component used in the system. The second step, localization, is to trace the trouble to the defective unit that is part of the faulty system and/or associated cabling or wiring. When performing bench maintenance on a removed electronic component, localization includes tracing the fault to a defective subassembly or module with the component. The third step, isolation, is to isolate the trouble within the component to a defective part.

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work and to aid in tracing troubles to the defective component.

(1) *Visual inspection.* Visual inspection is used to locate faults prior to operation or testing the circuits. Observe seating of all component connectors, connections to switches and circuit breakers, connections on terminals, wiring, etc., and sectionalize the fault to a particular component if possible.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. Operation tests are to be found in paragraph 5-9.

c. Localization. The procedures listed below are used for localizing troubles within the system to the electronic equipment components or system helicopter wiring.

(1) *Stability and control augmentation system performance testing.* Testing the complete stability and control augmentation system performance for normal operation often reveals the defective components.

(2) *Voltage and resistance measurements.* Use the system voltage and resistance chart (para 5-31) to find the normal readings, and compare them to the actual readings taken.

(3) *Intermittent troubles.* In all tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment and checking wiring and connections.

(4) *Signal substitution.* Signal substitution procedures enable the repairman to localize a component trouble quickly to a subassembly or part.

d. Isolation. After the trouble has been localized, the methods in (1) through (4) below will aid in isolating the trouble to a defective circuit element within a component.

(1) *Waveform analysis* (fig. 5-9). The waveform at the output of the valve driver module can be used to analyze failures in the circuit. Waveforms must be taken and compared with waveforms provided in figure 5-10. Resistance measurements ((3) below) then must be taken to isolate the trouble.

(2) *Voltage measurements.* This equipment is transistorized. When measuring voltages, use tape or sleeving (spaghetti) to insulate the entire test prod, except for the extreme tip. A momentary short circuit can ruin a transistor. Use the same or equivalent voltmeter specified on the voltage and resistance chart.

(3) *Resistance measurements.* Make resistance measurements in this equipment only as directed on voltage and resistance diagrams or charts. When using the voltmeter, set it to the resistance range specified on these charts; otherwise, the indications obtained will be inaccurate.

(4) *Intermittent troubles.* In all the tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Perform a visual inspection of the wiring and connections to the modules on the component. Minute cracks in a printed circuit board can cause intermittent operation. A magnifying glass is often helpful in locating defects in the printed circuit boards. Continuity measurements of printed conductors may be made by using the same technique ordinarily used on hidden conventional wiring; observe the voltmeter resistance measurement precautions discussed in (3) above.

5-21. Test Equipment Required

All test equipment and other equipment required to perform the tests in this chapter is listed below. (Refer to appendix A for list of manuals covering the test equipment.)

a. Electronic Voltmeter ME-30E/U (Voltmeter).

b. Multimeter AN/USM-223 (Multimeter).

c. Oscilloscope AN/USM-281 (Oscilloscope).

d. Signal Generator SG-298/U (Signal Generator).

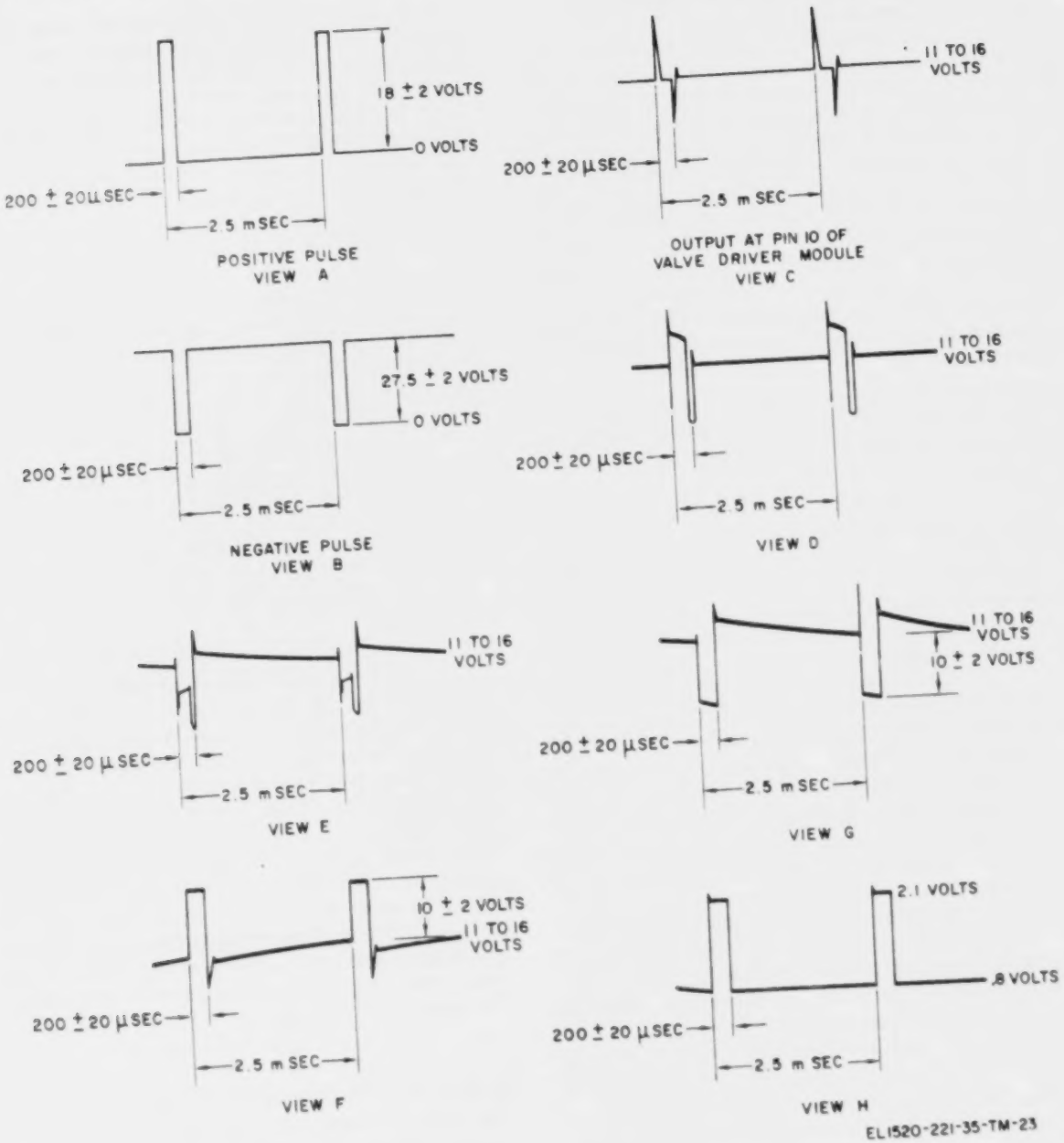

Figure 5-9. Valve driver module output waveforms.

e. Dc power source; 27.5 ±2.0 volts, 5 amps.

f. Ac power source; 115 V, 400 Hz, 50 va.

g. Test Set Electronic System AN/ASM-338 (SCAS test set).

h. Tool Kit, Electronic Equipment TK-101/G.

5-22. On-Ship Operational Checks and Troubleshooting

a. When a malfunction of the Stability and Control Augmentation System (SCAS) occurs, the first step in correcting the malfunction is to sectionalize the cause to a particular unit in the

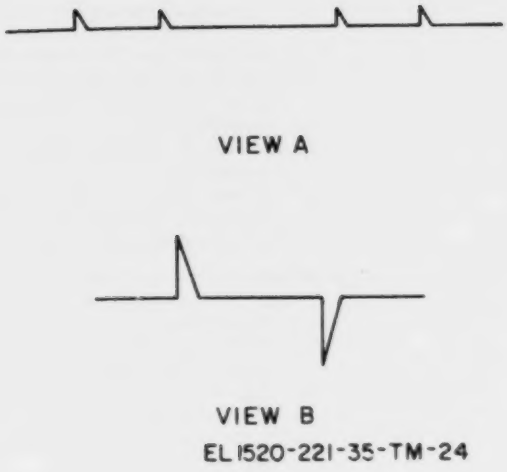

Figure 5-10. Valve driver output test waveforms.

system. Perform the on-ship operational checks and troubleshooting procedures in paragraph 5-24.

b. Since the controls for the basic components are remotely located, the troubleshooting procedures in this section may require more than one person. One man will be required to operate the controls and another to observe the results.

5-23. Test Setup

a. The operational tests in paragraph 5-24 are performed with the system installed in the AH-1G and AH-1Q helicopters. Electrical and hydraulic power is required. The POWER switch on the control panel should be OFF and the SAS PWR circuit breakers should be open.

b. The following equipment is required for operational tests in paragraph 5-24:

(1) Extender Module MX-8096/ASM-338 (extender board).

(2) Multimeter AN/USM-223.

5-24. On-Ship Operational Check and Troubleshooting Chart

Step	*Action*	*Normal Indication*	*If abnormal indications are observed*
1	Engage SAS CONT and SAS PWR circuit breakers. Set POWER switch on control panel to ON.	NO GO lights, PITCH, ROLL, and YAW, shall come on for less than 60 seconds and then go out.	*a.* If no lights come on: (1) Check bulbs by pressing to test. (2) Observe NO GO lights in sensor amplifier unit. If these come on and NO GO lights on the control panel do not, malfunction is in control panel. Substitute control panel known to be good. (3) Check 28-volt dc fuse F1 in the sensor amplifier unit. (4) Check for 28 volts dc to ground with volt-ohmmeter at pin D and pin S on the extender board in any channel (fig. 5-6, 5-7, and 5-8). If there is 28 volts dc at only one of these test points, change the sensor amplifier unit. If 28 volts dc is not present at either terminal, check 28-volt dc wiring. (5) With the controls centered, check the voltage between ground and pin M on the extender board of any channel. If the voltage is not from 6 to 15 volts dc, replace the sensor amplifier unit. (6) With hydraulic power off and electrical power on, engage switches should remain up (engaged); if not, check from pin J of the gyro connector (1J5/1P5) to ground for 26 volts ac. If 26 volts ac is not

Step	Action	Normal Indication	If abnormal indications are observed
			present, check 115-volt ac wiring. If the 115-volt ac circuit is operative, change the sensor amplifier unit. (7) Substitute the pulse generator module A2. (8) If the above checks do not isolate the malfunction, check each channel as in *b* below.
			b. If one or two NO GO indicator lights fail to illuminate. (1) Check bulbs. (2) Substitute B.I.T.E. module known to be good. (3) Substitute valve driver module known to be good. (4) Substitute control channel assembly known to be good. (5) If fault is not corrected by above procedure, substitute sensor amplifier unit known to be good. *Note.* By use of extender board, any control channel assembly may be used in any other channel of the sensor amplifier unit. (6) If fault is not corrected by the above procedure, substitute a control panel known to be good.
			c. If all NO GO lamps are lighted initially but one or more lamps fail to go out in less than 60 seconds: (1) Press GYRO TEST switch on sensor amplifier unit. If NO GO light goes out, trouble is in gyro. Replace gyro assembly A3. (2) Press ACTR TEST switch. If NO GO light goes out, trouble is in actuator circuit. (3) Balance control channel assembly. (*a*) Remove control channel assembly. (*b*) Insert extender board into sensor amplifier unit in place of control channel assembly. (*c*) Plug control channel assembly into the extender board. (*d*) Turn POWER switch on and allow 30 to 60 seconds for circuit to reach operating conditions. (*e*) Connect VOM between pin T and pin E of extender board, set the voltmeter to 10V scale. Reverse meter polarity if meter reading is negative.

Step	Action	Normal Indication	If abnormal indications are observed
			(*f*) Adjust R5 on the control channel assembly until VOM reads 0±0.1 volt. (*g*) Turn POWER off, remove extender board, and replace control channel assembly in sensor amplifier unit. (4) Substitute control channel assembly known to be good.
			d. If the Roll NO GO light fails to go out: (1) Substitute pylon compensation unit known to be good. (2) If fault is not corrected by above procedure, perform test outlines in *c*(1), (2), and (3) above.
2	**Engage Pitch switch**	**Engage switch remains in up position.**	*a.* **Substitute control panel.** *b.* Check emergency disengage circuit. Check continuity from pin H to pin P of P700. If open, check switches on pilot and gunner cyclic sticks. *c.* Substitute sensor amplifier unit known to be good. *d.* Check helicopter wiring.
3	Move cyclic stick forward	Pitch actuator should retract	*a.* Substitute control channel assembly known to be good. *b.* Check pitch control motion transducer (para 5-14). *c.* If both tests fail, check actuator circuit (para 5-15).
4	Engage Roll Switch	Engage switch remains in up position.	*a.* Substitute control panel. *b.* Check emergency disengage circuit. Check continuity from pin H to pin P of P700. If open, check switches on pilot and gunner cyclic sticks. *c.* Substitute sensor amplifier unit known to be good. *d.* Check helicopter wiring.
5	Move cyclic stick left	Roll actuator should retract	*a.* Substitute control channel assembly known to be good. *b.* Check roll control transducer (para 5-14). *c.* If both tests fail, check actuator circuit (para 5-15).
6	Engage Yaw switch	Engage switch remains in up position.	*a.* Substitute control panel. *b.* Check emergency disengage circuit. Check continuity from pin H to pin P of P700. If open, check switches on pilot and gunner cyclic sticks. *c.* Substitute sensor amplifier unit known to be good. *d.* Check helicopter wiring.
7	**Rotate sensor amplifier unit in a left yaw direction.**	**Yaw actuator should retract**	*a.* **Substitute control channel assembly known to be good.** *b.* **Substitute gyro assembly known to be good.** *c.* **Replace sensor amplifier unit.**

Step	Action	Normal Indication	If abnormal indications are observed
8	Reinstall sensor amplifier unit.		
9	Press emergency disengage switch on pilot's cyclic stick grip.	PITCH, ROLL and YAW engage switches immediately move to OFF position.	*a.* Substitute control panel known to be good. *b.* Check continuity from 2P1 pin p (control panel connector) to terminal E1 (ground); should be open. *c.* Measure resistance from pin H to pin P of J700. Should be 0 ohms. Press emergency disengage switch on pilot's and on gunner's cyclic stick. Should be open circuit when switch is depressed.

5-25. Bench Operational Check and Troubleshooting Chart, Control Panel

a. Connecting SCAS Control Panel and SCAS Test Set (fig. 5-11).

(1) Position test set controls as follows:

(*a*) PWR switches to OFF.

(*b*) CHANNEL switch to PITCH.

(*c*) MODE switch to CP.

(2) Set POWER switch on control panel to OFF.

(3) As shown in figure 5-11, connect control panel to the SCAS test set and the external power supply source with special purpose Electrical Cable Assemblies CX-10853/U and CX-10854/U, respectively.

b. Procedures.

Step	Action	Normal Indication	If abnormal indications are observed
1	Set EXT POWER switches on test set to ON positions.	Edgelit panel is lighted	DS4, DS5, or associated wiring defective (para 5-12).
2	Set POWER switch on control panel to POWER.	AC and DC lights on test set are lighted.	Faulty POWER switch S1 or associated wiring (para 5-5).
3	Depress momentarily all NO GO lights on control panel.	Lights will come on when depressed	Defective bulb, defective wiring, or defective engage switch.
4	Press NO GO TEST switch on test set.	All NO GO lights on control panel will come on.	Check control panel wiring.
5	Set PITCH, ROLL, and YAW engage switches on the control panel to up position.	*a.* Engage switches remain in up position. *b.* ENGAGED light on test set is lighted.	Defective switch or wiring in hold-in coil circuitry (para 5-5). (This step checks PITCH switch.)
6	Set CHANNEL selector on the test set to ROLL.	PITCH, ROLL, and YAW engage switches on control panel remain in up position, and ENGAGED light on test set remains lighted.	Defective switch or wiring in hold-in coil circuitry (para 5-5). (This step checks ROLL switch.)
7	Set CHANNEL selector on test set to YAW.	PITCH, ROLL, and YAW engage switches on control panel remain in up position, and ENGAGED light on test set remains lighted.	Defective switch or wiring in hold-in coil circuitry (para 5-5). (This step checks YAW switch.)
8	Depress EMER DISENGAGE switch on test set.	*a.* PITCH, ROLL, and YAW switches move to OFF. *b.* ENGAGED light on test set is not lighted.	Defective switch or wiring in hold-in coil circuitry (para 5-5).
9	Set CHANNEL selector on test set to ROLL.	ENGAGED light on test set goes out	Defective switch or wiring on hold-in coil circuitry (para 5-5).
10	Set CHANNEL selector on test set to PITCH.	ENGAGED light on test set goes out	Defective switch or wiring in hold-in coil circuitry (para 5-5).

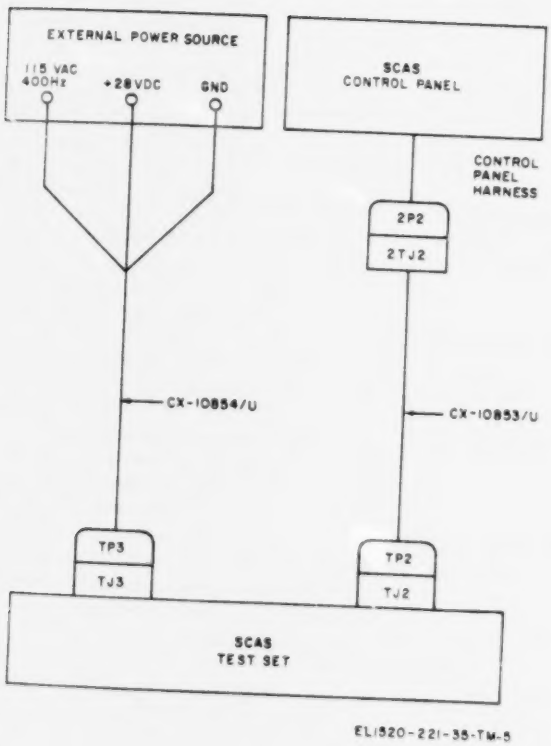

Figure 5-11. SCAS Control Panel Test setup connections.

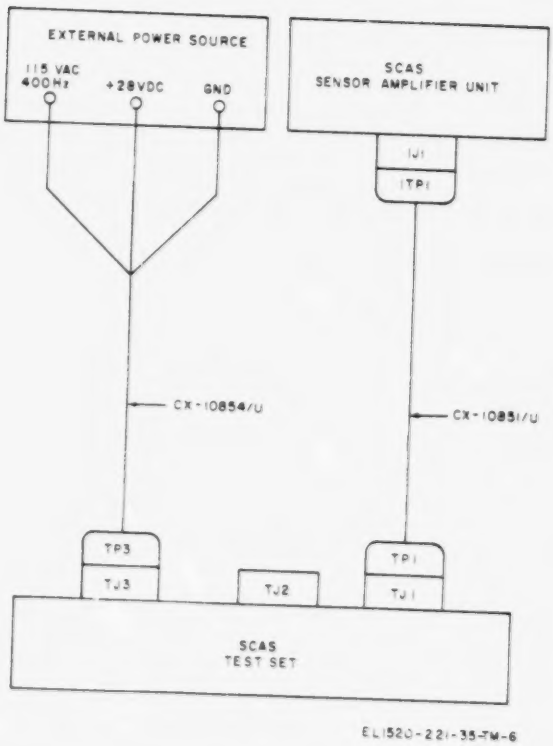

Figure 5-12. SCAS sensor amplifier unit test setup connections.

5-26. Bench Operational Check and Troubleshooting Chart, Sensor Amplifier Unit (fig. 5-12)

a. Connecting Sensor Amplifier Unit and SCAS Test Set.

(1) Position SCAS test set controls as follows:

(*a*) DC POWER switch to OFF.
(*b*) AC POWER switch to OFF.
(*c*) FEEDBACK knob to O.
(*d*) CHANNEL selector switch to PITCH.
(*e*) MODE selector switch to SAU.

(2) Connect voltmeter positive lead to

SCAS test set TP1 and negative lead to TP2, and set to 10V dc (not shown in fig. 5-12).

(3) Connect multimeter between SCAS test set TP5 and GRD and set to 3V scale (not shown in fig. 5-12).

(4) As shown in figure 5-12, connect the sensor amplifier unit to the SCAS test set and external power source with Special Purpose Cable Assemblies CX-10851/U and CX-10854/U, respectively.

b. Procedures.

Step	*Action*	*Normal Indication*	*If abnormal indications are observed*
1	Set AC and DC POWER switches on test set to ON. Adjust FEEDBACK for NULL reading on Multimeter.	*a.* AC and DC indicator lights on the test set come on. *b.* NO GO lights shall come on for less than 60 seconds and then go off.	Check ac and dc power circuitry. *a.* No NO GO lights come on in any channel upon first application of power. (1) Observe DC indicator light on test set. If it is off: (*a*) Check 28-volt fuse F1 (*b*) Check 28-volt power circuitry. If it is on: Check 28 volts dc to ground in any channel with voltmeter at pin D (28 volts dc) and pin S (filtered 28 volts dc) on the extender board to ground. If there is 28 volts dc at only one test point or if 28 volts dc does not appear at these test points, check 28-volt dc power circuitry. (2) Observe the AC indicator light on the test set. If off, check the 115-volt ac power circuitry, especially the ac interlock. (3) Check the voltage between ground and pin M (control signal) on the extender board of any channel. The voltage should be 6 to 15 volts dc; if not, check the +20-volt zener and associated circuitry. *b.* NO GO lights in one or two channels do not come on when power switches are turned on. (1) Check bulbs. (2) Substitute B. I. T. E. module known to be good in the faulty channel. (3) Substitute valve driver module known to be good in the faulty channel. (4) Substitute control channel assembly known to be good. (5) Check NO GO circuitry. *c.* NO GO lights stay on after warmup period. (1) If all NO GO lights stay on, press GYRO TEST button on sensor amplifier unit, and replace the gyro assembly if the lights go out when button is depressed.

Step	Action	Normal Indication	If abnormal indications are observed
			(2) Substitute pulse generator module known to be good if all lights stay on. (3) If one or two lights stay on after warmup, balance the control channel assembly (para 5-28). (4) Substitute valve driver module known to be good in defective channel. (5) Substitute control channel assembly known to be good.
2	Reverse DC meter polarity if meter reading is negative.	Voltmeter should read 0±.1 volt	*a.* Adjust balance by turning R5 until meter reading is 0±.1 volt. *b.* If balance cannot be adjusted, substitute control channel assembly known to be good.
3	Slowly lift rear of sensor amplifier unit to an angle of approximately 30 degrees momentarily and then return to original position.	Voltmeter will indicate + voltage when unit is lifted and returned to original position.	*a.* If no deflection, substitute gyro assembly known to be good. *b.* Substitute PITCH control channel assembly. *c.* Check sensor amplifier unit power circuits (para 5-5).
4	Rotate FEEDBACK knob clockwise until multimeter indicates 1 volt.	DC voltmeter indicates 3.1±.9 volts for pitch, 3.1±1 volts for roll, 6.4±.3 volts for yaw.	*a.* Substitute valve driver module if gain is low. *b.* Check control channel assembly (para 5-28). *c.* Check feedback circuitry.
5	Rotate FEEDBACK knob counterclockwise until multimeter indicates 0.5 volt.	DC voltmeter indicates 3.1±.9 volts for pitch, 3.1±1 volts for roll, 6.4±.3 volts for yaw.	*a.* Substitute valve driver module if gain is low. *b.* Check control channel assembly (para 5-28). *c.* Check feedback circuitry.
6	Set FEEDBACK knob to 0, rotate FEEDBACK knob counterclockwise until NO GO light illuminates.	NO GO light illuminates at 6±2 volts	*a.* Substitute B.I.T.E. module. *b.* Check control channel assembly (para 5-28).
7	Set FEEDBACK knob to 0, rotate FEEDBACK knob clockwise until NO GO light comes on.	NO GO light comes on at 6±2 volts.	
8	Momentarily depress ACTR TEST switch on the sensor amplifier unit.	NO GO light goes out when switch is depressed.	Check S2.
9	Adjust FEEDBACK knob to obtain null indication on multimeter.		
10	Connect signal generator to TP3 and TP4 on the test set. ***Caution:*** Do not ground TP3 or TP4. Dc bias is present on TP4.	None.	
11	Set oscilloscope controls as follows: *a.* VERTICAL SENSITIVITY: 2 volt cm. *b.* AMPLIFIER INPUT switches: DC *c.* HORIZONTAL SWEEP: .1 millisecond/cm. *d.* TRIGGER SOURCE: EXT-115 vac 400 Hz		

Step	Action	Normal Indication	If abnormal indications are observed
	Note. Use oscilloscope to adjust signal generator output for 10 volts peak to peak sine wave signal.		
12	Connect oscilloscope vertical lead to TP1 on the test set.	None.	
13	Adjust signal generator to frequency A as shown in table 5-1.	Observe peak-to-peak voltage indication as shown in table 5-1.	Refer to paragraph 5-28 to troubleshoot each control channel assembly.
14	Adjust signal generator to frequency B as shown in table 5-1.	Same as 13 above.	
15	Adjust signal generator to frequency C as shown in table 5-1.	Same as 13 above.	
16	Remove signal generator	None.	
17	Reverse Voltmeter polarity (+ DC).	None.	
18	Set CHANNEL selector on the test set to ROLL.	None.	
19	Slowly raise left side (when viewed from front) of sensor amplifier unit to produce an angular motion.	Voltmeter indicates positive voltage during motion.	*a.* If no deflection, substitute gyro assembly. *b.* Substitute PITCH control channel assembly. *c.* Check sensor amplifier unit power circuits (para 5-5).
20	Lower left side of sensor amplifier unit to original position.	None.	
21	Repeat 4 through 17 above to test roll channel.	Same as 4 through 17 above.	
22	Set CHANNEL selector on the test set to YAW.	None.	
23	Slowly rotate the sensor amplifier unit counterclockwise.	Voltmeter indicates positive voltage during motion.	*a.* If no deflection, substitute gyro assembly. *b.* Substitute PITCH control channel assembly. *c.* Check sensor amplifier unit power circuits (para 5-5).
24	Rotate the sensor amplifier unit clockwise to original position.	None.	
25	Repeat 4 through 17 above to test yaw channel.	Same as 4 through 17 above.	
26	Connect positive lead of voltmeter to pin M of TJ2, on the test set. Connect negative lead of voltmeter to GND.	Voltmeter should read 27.5±2.0 vdc	*a.* If no voltage, substitute relay known to be good. *b.* Check associated relay energizing circuitry.
27	Set AC Power switch to OFF.	Voltmeter indicates 0 volts	*a.* If voltage remains, substitute relay known to be good. *b.* Check associated relay energizing circuitry.

Table 5-1

	Frequency (Hz)	Pitch Output Vp-p	Roll Output Vp-p	Yaw Output Vp-p
A.	.03	2.4±0.8	5.0±1.5	5.0±1.5
B.	.1	3.3±1.0	8.5±2.5	8.5±2.5
C.	.5	1.8±0.6	3.0±1.0	3.0±1.0

5-27. Control Panel and Sensor Amplifier Unit Operational Check and Troubleshooting Chart

a. Connect control panel, sensor amplifier unit and the external power source to the SCAS test set as shown in figure 5-13 as follows:

(1) Position test set controls as follows:

(*a*) POWER switches OFF.

(*b*) CHANNEL switch to PITCH.

(*c*) MODE switch to CP/SAU.

(*d*) FEEDBACK knob to 0.

(2) Connect voltmeter positive lead to SCAS test set TP1 and negative lead to TP2, and set to 10 vdc scale (not shown in fig. 5-13).

(3) Connect multimeter between SCAS test set TP5 and GRD and set to 3V scale (not shown in fig. 5-13).

(4) Connect the SCAS test set to the control panel, sensor amplifier unit, and external power source using Special Purpose Cable Assemblies CX-10853/U, CX-10851/U and CX-10854/U, respectively.

(5) Position POWER switch on control panel to OFF.

(6) Open access cover on front of sensor-amplifier unit.

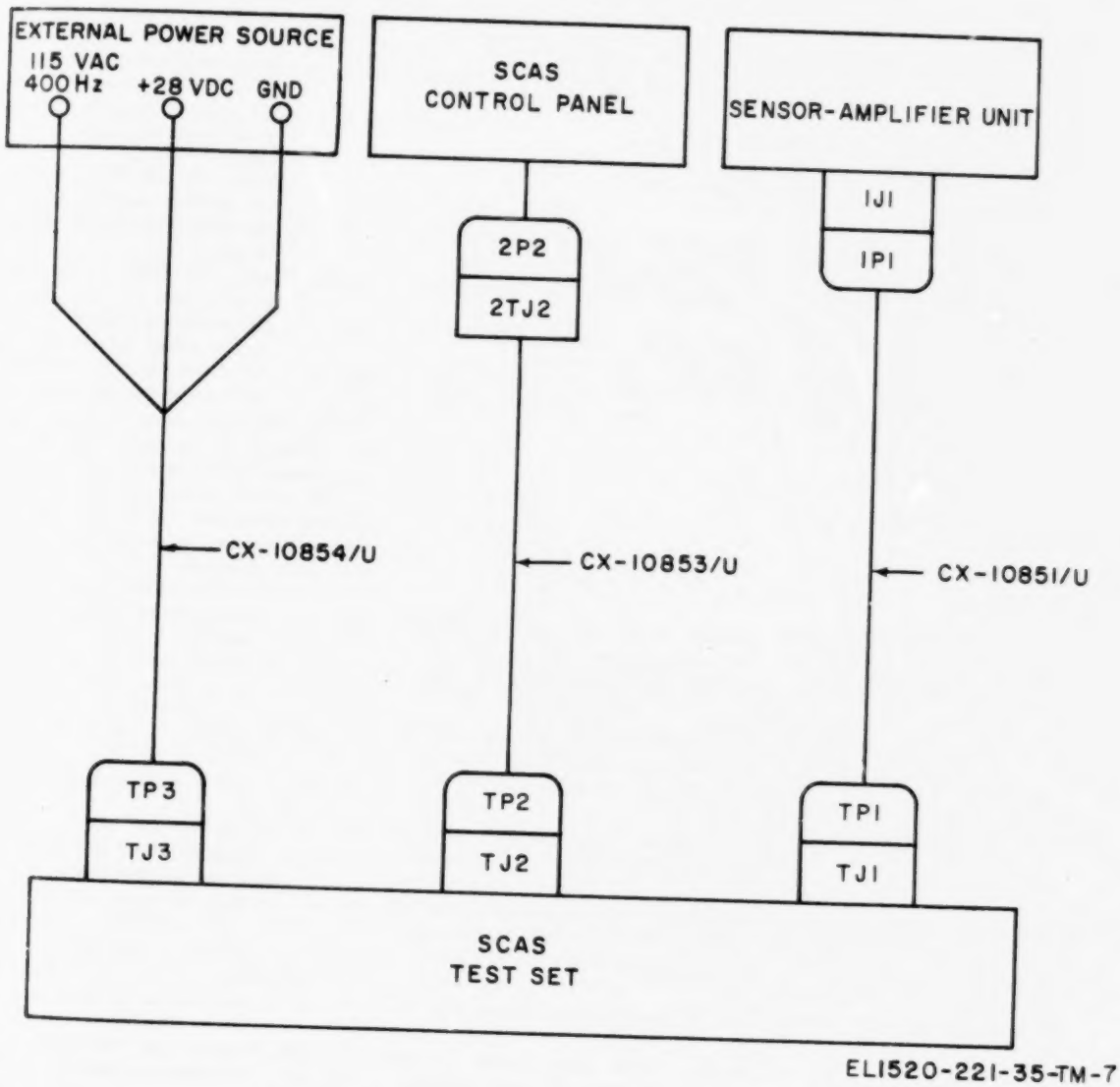

Figure 5-13. SCAS control panel and sensor amplifier unit test setup connections.

b. Procedures.

Step	Action	Normal Indication	If abnormal indications are observed
1	Set ac and dc POWER switches on test set to ac and dc.	Control panel edge lights come on	DS4, DS5, or associated wiring bad (para 5-12).
2	Set POWER switch on the control panel to POWER.	PITCH, ROLL and YAW NO GO lights and the NO GO light on the test set come on for less than 60 seconds and then go out. AC and DC lights on the test set come on.	Check AC and DC circuitry according to paragraph 5-12. *a.* No NO GO lights illuminate in any channel upon first application of power. (1) Observe 28-volt indicator light on test box. If off— (*a*) Check 28-volt fuse. (*b*) Check 28-volt power circuitry. If on— (2) Check 28 volts dc to ground in any channel with a voltmeter at pin D (28 volts) and pin S (filtered 28 volts) on the extender board to ground. If there is 28 volts at only one pin or if no 28 volts appears at these points, check 28-volt power circuitry. (3) Observe the 115-volt ac indicator light on the test box. If off, check the 115-volt power circuitry. (4) Check the voltage between ground and pin M (control signal of any channel). The voltage should be 6 to 15 volts dc; if not, check the +20-volt zener and associated circuitry. *b.* NO GO lights in one or two channels do not come on when power switches are turned on. (1) Check bulbs. (2) Substitute B. I. T. E. module known to be good in faulty channel. (3) Substitute valve driver module known to be good in faulty channel. (4) Substitute control channel assembly known to be good. Repair (para 5-28). (5) Check NO GO circuitry by 570-078-016. *c.* NO GO lights stay on after warmup period. (1) If all NO GO lights stay on, press GYRO TEST button on sensor amplifier unit, and replace the gyro assembly (fig. 5-10) if lights go out when button is depressed. (2) Substitute pulse generator module known to be good if all lights stay on. (3) If one or two lights stay on after warmup, balance the control channel assembly (para 5-28).

Step	Action	Normal Indication	If abnormal indications are observed
			(4) Substitute valve driver module known to be good in defective channel. (5) Substitute control channel assembly known to be good. Repair (para 5–28).
		Note. The AC and DC indicator lights on the test set stay on except as specifically stated in this test.	*d.* Bad S1 or associated wiring (para 5–5).
3	Set multimeter to .1-volt scale	None.	
4	Adjust FEEDBACK knob on the test set to obtain null indication on the multimeter.	None.	
5	Adjust R5 potentiometer in the PITCH channel assembly of the sensor amplifier unit to obtain 0 indication on the voltmeter.	None.	
6	Set CHANNEL selector on the test set to ROLL.	None.	
7	Repeat 5 above	None.	
8	Set CHANNEL selector on the test set to YAW.	None.	
9	Repeat 5 above.		
10	Set PITCH, ROLL, and YAW engage switches on the control panel to up (engaged) position.	ENGAGED light on the test set illuminates. PITCH, ROLL, and YAW engage switches remain engaged.	Bad switch or wiring in hold-in coil coil circuitry (para 5–5). (This step checks yaw switch.)
11	Set CHANNEL selector on the test set to ROLL. *Note.* When the CHANNEL selector on the test set is rotated to a new position, the NO GO light on the test set may come on for a few seconds and then go out. If any of the engage switches on the control panel are not engaged, the appropriate NO GO light may illuminate.	PITCH, ROLL, and YAW engage switch on control panel remain engaged. ENGAGED light on the test set remains illuminated.	Bad switch or wiring in hold-in coil circuitry (para 5–5). (This step checks roll switch.)
12	Set CHANNEL selector on the test set to PITCH.	PITCH, ROLL, and YAW engage switches on the control panel remain engaged. ENGAGED light on the test set stays on.	Bad switch or wiring in hold-in coil circuitry (para 5–5). (This step checks pitch switch.)
13	Depress momentarily the EMER DISENGAGE switch on the test set.	PITCH, ROLL, and YAW engage switches immediately move to OFF. ENGAGED light on the test set goes out.	Bad switch or wiring in hold-in coil circuitry (para 5–5).
14	Set PITCH, ROLL, and YAW switches on the control panel to engaged position.	Engage switches hold in engaged position. ENGAGED light on the test set comes on.	
15	Set AC switch on the test set to OFF.	PITCH, ROLL, and YAW switches on the control panel immediately move to OFF. ENGAGED and AC lights on the test set go out.	Bad AC interlock relay. Bad rectifying diode. Bad filter capacitor. Bad AC wiring (para 5–8). Bad coil circuitry.
16	Set AC switch on the test set to AC.	AC light on the test set comes on	Faulty S1 or associated wiring.
17	Set PITCH, ROLL, and YAW engage switches on the control panel to engaged position.	PITCH, ROLL, and YAW engage switches hold in engaged position. ENGAGED light on the test set comes on.	

Step	Action	Normal Indication	If abnormal indications are observed
18	Set POWER switch on control panel to OFF.	PITCH, ROLL, and YAW engage switches immediately move to OFF. ENGAGED, AC, and DC lights on the test set go out.	Bad switch or wiring in hold-in coil circuitry.
19	Set POWER switch on the control panel to engaged position.	NO GO lights on the control panel and test set come on for approximately 60 seconds or less, and then go out. AC and DC indicators on the test set come on.	Same as step 2.
20	Adjust FEEDBACK knob on the test set to obtain 0 indication on the voltmeter.	None.	
21	Slowly raise the aft side of the sensor amplifier unit to produce an angular position.	Voltmeter indicates positive voltage	*a.* If no deflection, substitute gyro assembly (fig. 5-15). *b.* Substitute pitch control channel assembly. *c.* Check sensor amplifier unit power circuits (para 5-5).
22	Return sensor amplifier unit to original position.	Voltmeter indicates 0.	
23	Turn FEEDBACK knob clockwise until multimeter indicates 0.5 volt.	DC voltmeter should indicate— 3.1±0.9 volts for pitch, 4.0±1.2 volts for roll, 7.0±2.1 volts for yaw.	*a.* Substitute valve driver if gain is low. *b.* Check control channel assembly (para 5-28). *c.* Check feedback circuitry.
24	Rotate FEEDBACK knob to 0 then clockwise until	Voltmeter indication is 6 ±2 volts	*a.* Substitute B.I.T.E. module assembly (para 5-8). *b.* Check control channel assembly (para 5-28).
25	Return FEEDBACK knob to 0	None.	
26	Reverse voltmeter polarity (+dc).		
27	Turn FEEDBACK knob counterclockwise until multimeter indicates 0.5 volt.	DC voltmeter should indicate— 3.1±0.9 volts for pitch, 4.0±1.2 volts for roll, 7.0±2.1 volts for yaw.	*a.* Substitute valve driver if gain is low. *b.* Check control channel assembly (para 5-28). *c.* Check feedback circuitry.
28	Rotate FEEDBACK knob to 0, then counterclockwise until NO GO lights come on.	Voltmeter indication is 6±2 volts	*a.* Substitute B.I.T.E. module 570-074-048-1. *b.* Check control channel assembly (para 5-28).
29	Remove voltmeter from test set.	None.	
30	Depress and hold ACTR TEST switch on the set.	NO GO lights go out	Check switch.
31	Release ACTR TEST switch	NO GO lights come on.	
32	Adjust FEEDBACK knob to obtain nuil indication on the voltmeter.	None.	
33	Connect signal generator to TP3 and TP4 on the test set. ***Caution:*** Do not ground TP3 or TP4. DC bias is present on TP4.	None.	
34	Set oscilloscope switches as follows: VERTICAL SENSITIVITY: 2 VOLT/CM AMPLIFIER INPUT switches: DC HORIZONTAL SWEEP: .1 MILLISECOND/CM	None.	

Step	Action	Normal Indication	If abnormal indications are observed
	TRIGGER SOURCE: EXT 115 vac, 400 Hz. *Note.* Use oscilloscope to adjust signal generator output for 10-volt peak-to-peak sine wave signal.		
35	Connect oscilloscope vertical lead to TP1 on the test set.	None.	
36	Adjust signal generator to frequency A as shown in table 5-1.	Observe peak-to-peak voltage indication on the oscilloscope. Acceptable performance standard is listed in table 5-1.	Refer to paragraph 5-28 to troubleshoot each control channel assembly.
37	Adjust signal generator to frequency B as shown in table 5-1.	Same as 36 above.	
38	Adjust signal generator to frequency C as shown in table 5-1.	Same as 36 above.	
39	Remove signal generator	None.	
40	Connect voltmeter positive to TP1 and negative lead to TP2. Set at 10 vdc and +DC.	None.	
41	Set CHANNEL selector on the test set to ROLL.	None.	

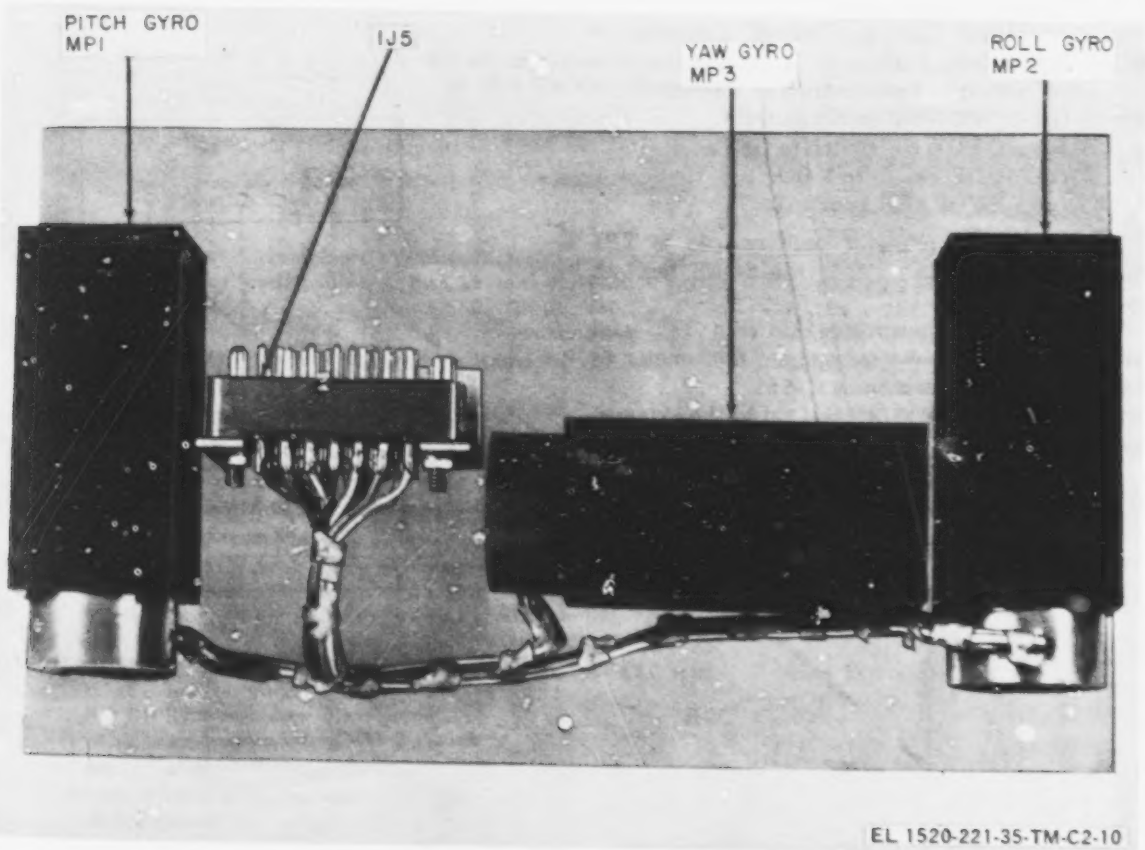

Figure 5-11. Three axis gyro assembly.

Step	Action	Normal Indication	If abnormal indications are observed
42	Slowly raise left side (when viewed from front) of sensor amplifier unit to produce an angular motion of the sensor amplifier unit.	Voltmeter indicates positive voltage during motion.	*a.* If no deflection, substitute gyro assembly. *b.* Substitute pitch control channel assembly. *c.* Check sensor amplifier unit power circuits (para 5-5).
43	Lower left side of sensor amplifier unit to original position.	None.	
44	Repeat 23 through 40 to test roll channel.	Same as 23 through 40 above.	
45	Set CHANNEL selector on the test set to YAW.	None.	
46	Slowly rotate the sensor amplifier unit counterclockwise.	Voltmeter indicates positive voltage during motion.	*a.* If no deflection, substitute gyro assembly. *b.* Substitute pitch control channel assembly. *c.* Check sensor amplifier unit power circuits (para 5-5).
47	Return the sensor amplifier unit to original position.	None.	
48	Repeat 23 through 40 to test yaw channel.	Same as 23 through 40 above.	

5-28. Bench Operational Check and Troubleshooting Chart, Control Channel Assembly

a. Connecting Control Channel Assembly to SCAS Test set (fig. 5-15).

(1) Position test set controls as follows:

(*a*) DC POWER switch to OFF.

(*b*) AC POWER switch to OFF.

(*c*) MODE switch to MOD.

(*d*) FEEDBACK knob to 0.

(2) Connect voltmeter positive lead to TP1 and negative lead to TP2 on the SCAS test set (not shown on fig. 5-15).

(3) Connect multimeter between TP5 and GRD on the SCAS test set and set multimeter to 3-volt scale (not shown on fig. 5-15).

(4) Connect the SCAS test set to the external power source using cable assembly CX-10854/U.

(5) Insert control channel assembly 570-074-037-7, -15, or -11 into TJ4 of the test set.

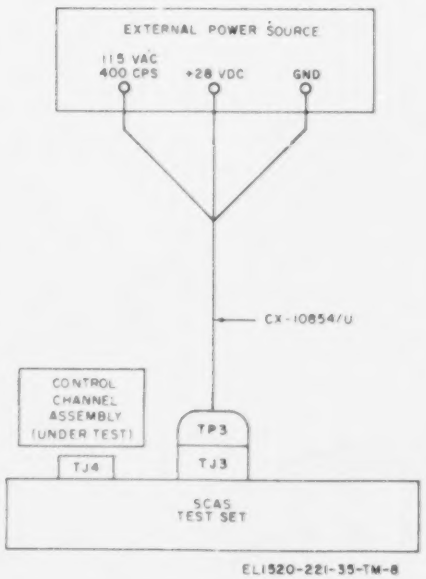

Figure 5-15. Control channel assembly test setup connections.

b. Procedures.

Step	*Action*	*Normal Indication*	*If abnormal indications are observed*
1	Set AC and DC POWER switches to AC and DC.		
2	Adjust FEEDBACK knob for null indication on VTVM.		
3	Adjust R5 on control channel assembly to obtain 0±1.V indication on VOM.		
4	Set AC and DC POWER switches to OFF.		
5	Set POWER switches on test set to AC and DC.	*a.* NO GO light on the test set comes on and goes off in less than 60 seconds.	*a.* Substitute B.I.T.E. module. *b.* Substitute valve driver module. *c.* Check R8. *d.* Check R7. *e.* Defective 28-volt dc circuitry on board (both pins D and S) (para 5–5). *f.* Defective NO GO circuitry (para 5–5). *g.* Check ground circuitry (pin 6 of B.I.T.E. to ground through pin) and check all of the ground circuitry on control channel assembly. *h.* Defective pulse generator circuitry from pulse generator through the entire control channel assembly (para 5–9).
		b. NO GO light comes on but does not go off in less than 60 seconds.	*a.* Defective B.I.T.E. module. *b.* Defective valve driver module. *c.* Check power and ground circuitry (para 5–5). *d.* Check R4, R3, R18, R11, R5, RT1, R6, CR1, R10, R9, and R21. *e.* Check C6, R20, C2, and R14. *f.* Check R22 (Roll only).
6	Turn FEEDBACK knob clockwise until multimeter indicates 0.5 volt.	VOM indicates— 3.1±0.9 volts for pitch, 4.0±1.2 volts for roll, 7.0±2.1 volts for yaw.	*a.* Substitute valve driver module. *b.* Check R7 and R1. *c.* Check R13, R21 and R9. *d.* Check R6 and CR1.
7	Turn FEEDBACK knob to 0, then clockwise until NO GO light comes on.	VOM indicates 6.0±2.0 volts	*a.* Check B.I.T.E. module. *b.* Check valve driver module. *c.* Check pulse circuitry on control channel assembly (para 5–9). *d.* Check CR1 for 20 vdc. *e.* Check R3 and R4.
8	Return FEEDBACK knob to 0	None.	
9	Reverse voltmeter polarity	None	Same as 6 above.
10	Turn FEEDBACK knob counterclockwise until multimeter indicates 0.5 volt.	Voltmeter indicates— 3.1±0.9 volts for pitch, 4.0±1.2 volts for roll, 7.0±2.1 volts for yaw.	
11	Turn FEEDBACK knob to 0, then counterclockwise until NO GO light comes on.	Voltmeter indicates 6.0±2.0 volts	Same as 7 above.
12	Remove voltmeter from test set.	None.	
13	Adjust FEEDBACK for null on multimeter.		
14	Connect signal generator to TP3 and TP4.		

Step	Action	Normal Indication	If abnormal indications are observed
	Caution: Do not ground TP3 or TP4. Dc bias is present on TP4.		
15	Set oscilloscope VERTICAL SENSITIVITY to 2 volt cm.		
16	Set oscilloscope AMPLIFIER INPUT switches to DC.		
17	Set oscilloscope HORIZONTAL sweep to .1 MILLISECOND/CM.		
18	Set oscilloscope TRIGGER SOURCE to EXT-115 vac, 400 Hz.		
19	Use oscilloscope to adjust signal generator output for 10-volt peak-to-peak sine wave signal.		
20	Connect oscilloscope vertical lead to TP1.		
21	Adjust signal generator to frequency A as shown in table 5-1. Observe and record peak-to-peak voltage indication on oscilloscope.	Observe peak-to-peak voltage indication on the oscilloscope. Normal indication is listed in table 5-1.	
22	Adjust signal generator to frequency B in table 5-1. Observe and record peak-to-peak voltage indication on oscilloscope.	Same as 21 above.	
23	Adjust signal generator to frequency C in table 6-1. Observe and record oscilloscope peak-to-peak indication. Acceptable values are shown in table 5-1.	Same as 21 above	*a.* Check valve driver. *b.* Check R1. *c.* Set the signal generator for 20 volts peak-to-peak sine wave signal at .1 Hz, and check + side of C4 for approximately .6 volt for PITCH, .6 volt for ROLL, and .7 volt for YAW peak-to-peak summed with approximately 10 volts dc. *d.* Check pin 2 of T1 for approximately .55 volt for PITCH, .6 volt for ROLL, and .7 volt for YAW, peak-to-peak. *e.* Check + side of C5 for approximately .4 volt for PITCH, .6 volt for ROLL, and .4 volt for YAW, peak-to-peak at .1 Hz summed with approximately 10 volts dc. If there is no voltage, check CR3, CR4, CR5, CR6, and C5. *f.* Check the collector of Q1 for 20±1 volts dc. If there is no voltage present, check R6 and CR1. *g.* Check the emitter of Q1 for approximately .35 volt for PITCH, .5 volt for ROLL, and .4 volt for YAW, peak-to-peak at .1 Hz summed with approximately 10 volts dc. *h.* Check between C6 and R20 for approximately .3 volt for PITCH, .5 volt for ROLL, and .3 volt for YAW at .1 Hz. If there is no

Step	Action	Normal Indication	If abnormal indications are observed
			voltage present, check C6 and R20.
24	Position AC and DC power switches to OFF.	None.	
25	Remove assembly under test from TJ4.	None.	
26	Insert 570-091-011-1 extender card into TJ4.	None.	
27	Set oscilloscope switches as follows: VERTICAL SENSITIVITY 0.1 volt/cm AMPLIFIER INPUT switches: DC HORIZONTAL SWEEP: 5 msec/cm TRIGGER SOURCE: EXT-115 vac, 400 Hz.	None.	
28	Connect oscilloscope input leads to pins P and L on extender card.	None.	
26	Position AC and DC power switches to AC and DC.	None.	
30	Adjust amplitude of signal generator to obtain 0.2 volts peak-to-peak modulation envelope.	Oscilloscope should indicate 0.2 volts peak-to-peak.	
31	Position AC and DC power switches to OFF.	None.	
32	Remove extender card and insert control assembly in TJ4.	None.	
33	Set oscilloscope switches as follows: VERTICAL SENSITIVITY: 2 volt/cm. AMPLIFIER INPUT switches: DC HORIZONTAL SWEEP: 0.1 msec/cm. TRIGGER SOURCE: EXT-115 vac, 400 Hz.	None.	
34	Connect oscilloscope vertical input to TP1. Position AC DC switches to AC and DC.	None.	
35	Adjust frequency of signal generator to frequency A in table 5-2.	Observe peak-to-peak indication on oscilloscope. Performance standard is listed in table 5-2.	*a.* Substitute valve driver module known to be good. *b.* Check R1 and R7. *c.* Check pin 2 of T1 for approximately .25 volt for pitch, .3 volt for roll, and 1.2 volts for yaw. *d.* Check + side of C5 for approximately .25 volt for Pitch, .3 volt for roll, and 1.2 volt for yaw, peak-to-peak at .1 Hz summed with approximately 10 volts dc. If there is no voltage, check CR3, CR4, CR5, CR6, and C5. *e.* Check the collector Q1 for 20 vdc. If there is no voltage present, check R6 and CR1. *f.* Check the emitter of Q1 for approximately .25 volt for pitch, .2 volt for roll, and 1.2 volts for yaw,

Step	Action	Normal Indication	If abnormal indications are observed
			peak-to-peak at .1 Hz summed with approximately 10 vdc.
			g. Check between C6 and R20 for approximately .15 volts for pitch, .2 volt for roll, and 1 volt yaw, at .1 Hz. If there is no voltage present, check C6 and R20.
			h. Check the waveform at pin 10 of the valve driver module (para 5-30).
36	Adjust frequency of signal generator to frequency B in table 5-2.	Observe peak-to-peak indication on osc. Performance standard is listed in table 5-2.	Same as 35.
37	Adjust frequency of signal generator to frequency C in table 5-2.	Observe peak-to-peak indication on osc. Performance standard is listed in table 5-2.	Same as 35.

Table 5-2

	Frequency (Hz)	Pitch Output Vp-p	Roll Output Vp-p	Yaw Output Vp-p
A	.03	2.5±.6	1.9±.6	1.8±.6
B	.1	3.5±1	2.6±.9	2.6±.9
C	.5	2.0±.6	1.5±.5	1.5±.5

5-29. Pylon Compensation Unit Operational Check and Troubleshooting Chart

a. Connecting Pylon Compensation Unit to SCAS Test set (fig. 5-16).

(1) Position test set controls as follows:

(*a*) POWER switches OFF.

(*b*) The position of the other controls is not applicable to this test. They may be set in any position.

(2) Connect the pylon compensation unit to the external power source and the SCAS test set using cable assemblies CX-10854/U and CX-10852/U, respectively.

(3) Connect voltmeter positive lead to TP8 and negative lead to GRD on the SCAS test set (not shown in fig. 5-16). Set voltmeter to 50 vdc scale.

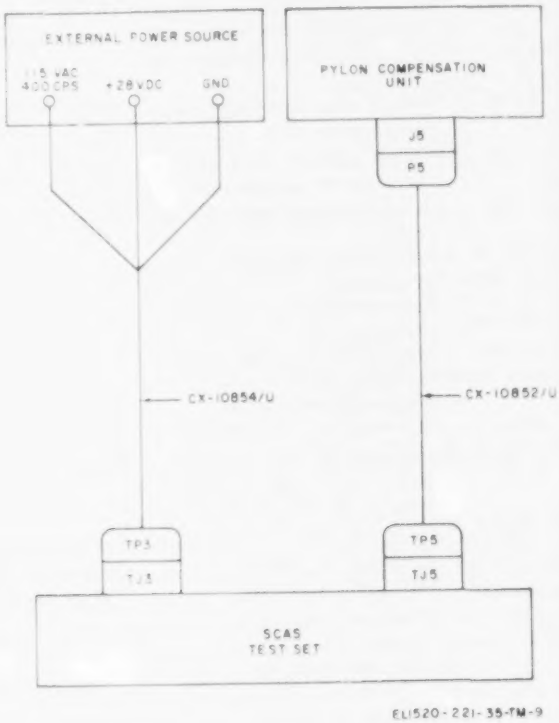

Figure 5-16. Pylon compensation unit test setup connections.

b. Procedure.

Step	Action	Normal Indication	If abnormal indications are observed
1	Turn on external power source	None.	
2	Position dc power switch to DC.	Voltmeter indicates 10±1 vdc	*a.* Check R11. *b.* Check CR1. *c.* Check continuity from pin G, J1 to E2.

Step	Action	Normal Indication	If abnormal indications are observed
3	Connect voltmeter positive lead to TP10.	Voltmeter indicates 10±1 vdc	*a.* Check R11. *b.* Check CR1. *c.* Check continuity from pin H, J1 E2.
4	Disconnect voltmeter	None.	
5	Set osc as follows: VERTICAL SENSITIVITY: 1 volt/cm; AMPLIFIER INPUT SWITCHES: DC; HORIZONTAL SWEEP: 0.1 msec/cm; TRIGGER SOURCE: EXT 115 vac, 400 Hz.	None.	
6	Using osc, adjust signal generator to a 1.0 Hz sinewave output with a peak-to-peak amplitude of 3.0 volts.	None.	
7	Connect generator output to TP8 and TP9 of test set. ***Caution:*** DC bias is present on TP8, do not ground.	None.	
8	Set vertical sensitivity on osc to 10 millivolts/cm.	None.	
9	Connect vertical input of osc to TP7 of the test set.	Osc should indicate 40±15m/volts peak-to-peak.	*a.* Check R1, R2, R3, R4, R5, and C1. *b.* Check R9, R10, and C5.
10	Set vertical sensitivity on osc to 20m/volts/cm.	None.	
11	Adjust signal generator to 2.5 Hz.	Osc should indicate 130±20m/volts peak-to-peak.	Same as 9.
12	Set vertical sensitivity on osc to 50m/volts/cm.	None.	
13	Adjust signal generator to 4.0 Hz.	Osc should indicate 200±30m/volts peak-to-peak.	Same as 9.
14	Adjust signal generator to 8.0 Hz.	Osc should indicate 180±50m/volts peak-to-peak.	*a.* Check R1, R2, R3, R4, R5, and C1. *b.* Check R9, R10, and C5. *c.* Check R6, R7 R8, C2, C3, and C4.
15	Set vertical sensitivity on osc to 10m/volts/cm.	None.	
16	Adjust signal generator output frequency to obtain a null on the osc.	Null frequency should be 11±1 Hz	Check R6, R7, R8, C2, C3, and C4.
17	Set vertical sensitivity on osc to 0.1 volt/cm.	None.	
18	Adjust signal generator to 20.0 Hz.	Osc should indicate 650±90m/volts peak-to-peak.	Same as 14.
19	Set vertical sensitivity on osc to 0.2 volts/cm.	None.	
20	Adjust signal generator to 40.0 Hz.	Osc should indicate 1.5±0.2 volts peak-to-peak.	Same as 14.

5–30. Sample Waveforms

The waveforms illustrated in (fig. 5–9) are provided for comparison with the waveforms taken by the repairman.

a. Positive pulse from pin pp of pulse generator module is applied through pin H of connectors 1J2, 1J3, and 1J4 to pin 3 of the valve driver module for gating of the input (fig. 5–9, view A).

b. Negative pulse from pin NP is applied to pin 4 of the 324–5D transformer through pin F of connectors 1J2, 1J3, 1J4 to synchronize the demodulator in the compensating circuit to 400 Hz. The negative pulse is also applied through pin F of connector 1J2, 1J3, and 1J4 to pin 2 of the valve driver module to gate this module in synchronism with 400 Hz (fig. 5–9, view B).

c. For zero signal input, the reference level of the output at pin 10 of the valve driver is set by the amount of regulated 20 volts dc received through RT1 from CR1 which is applied at pin 4 after being attenuated by R3 and R4. A combination of all signals that are applied at pin 6 also appears at pin 10 in the form of a 200-usec pulse with a repetition of 400 Hz. The level of this pulse for zero signal on the input is set at the same level as the reference output value by the amount of 20 volts dc received through RT1 from CR1 which is applied at pin 4 after being attenuated by R5, R11, R18, and R10. R5 allows the pulse and the reference outputs at pin 10 to be balanced for minor production and aging tolerances. The correct balanced output appears at pin 10 of the valve driver module for zero signal input (fig. 5-9, view C).

d. For output at pin 10 of the valve driver as a result of the control channel assembly being unbalanced in the positive direction or a positive signal being applied at the input terminal pin 6, see figure 5-9, view D.

e. For output of pin 10 of the valve driver as a result of the control channel assembly being unbalanced in the negative direction or a negative signal being applied at the input terminal pin 6, see figure 5-9, view E.

f. For the valve driver in a saturated condition as a result of warmup, large positive signal on the input, or a malfunction, see figure 5-9, view F.

g. For the valve driver in a saturated condition as a result of a large negative signal on the input or a malfunction, see figure 5-9, view G.

h. For waveform at pin 6 of the valve driver module, see figure 5-9, view H.

5-31. Voltage and Resistance Measurements Chart

The following chart of system voltages and resistances is furnished as an aid to troubleshooting and repair of the stability and control augmentation system.

NOTE

All resistance measurements *must* be taken with power off.

Neg. lead from	*Point of measurement positive lead*	*Normal indication* *Voltage*	*Normal indication* *Voltage-off resistance*	*Isolating procedure*
	With A2, K1, A4, A5, A6 removed and 1P5 unplugged.			
Grd	Pin 5 of 1J6	28 V DC	Infinity	If low, check CR1, L1, C2, and shorts in wiring (fig. 5-17 and 5-18).
Grd	E4	28 V DC	Infinity	
Grd	DA6, DA5, DA4, IN of L1	28 V DC	Infinity	
	Pin GRD of A2		0	Check A. If high, check continuity pin 1 of A1 to ground. Check Grd of A2 to pin 3 of A1.
	Pin 2 of A1		Infinity	
	Pin 3 of A1		Infinity	Replace A1.
	Pin 4 of A1		Infinity	Replace A1.
	Pin 5 of A1		Approximately 2.6Ω.	If shorted, check wiring and A1. If open, check A1 and continuity. Check gyro test switch if open.
	Pin 6 of A1		Infinity	Grd of A2 to pin 3 of A1.
	Pin 7 of A1		Infinity	Grd of A2 to 3A1.
Grd	Pin 3 of A1	115V ac 400 Hz		Check continuity from pin 3 of A1 to pin R of 1J1.
Grd	Pins A, B, and F of 1J5	0 volts		Check continuity from pins A, B, and F to grd.
Grd	Pins D, E, and K of 1J5	26V ac 400 Hz.		Check continuity from pins D, E, and K to pin 5 of A1. Check continuity between pins 1 and 2 of gyro test switch. If no voltage at pin 5 of A1 with pin 5 open, replace A1.
Grd	Pin L of 1J5	26V ac 400 Hz.		Check continuity from pin L of 1J5 to pin 7 of A1. If zero ohms but no voltage, replace A1.

Neg. lead from	Point of measurement positive lead	Normal indication: Voltage	Normal indication: Voltage-off resistance	Isolating procedure
Grd	Pin M of 1J5	26V ac 400 Hz.		Check continuity from pin M of 1J5 to pin 6 of A1.
Pin 5 A1	E5		1.8Ω	If shorted, check wiring and A1. If open, check A1 and continuity. Check gyro test switch if open.
Grd	E5		.8Ω	If shorted, check wiring and A1. If open, check A1 and continuity. Check gyro test switch if open.
IN of L1	S of A4 and 1 of L1		Approximately 43Ω.	Check continuity from 5 to terminal 1. L1 bad if shorted or open.
IN of L1	S of A5 and 2 of L1		Approximately 43Ω.	Check continuity from 5 to terminal 1. L1 bad if shorted or open.
IN of L1	S of A6 and 3 of L1		Approximately 43Ω.	
	Power on, all control channel assemblies, signal generator module removed and 1P5 removed.			
Grd	Pin S of 1J5	26V ac 400 Hz.		Check continuity from pin S of 1J5 to pin 2 of A1.
Grd	Pins H, J, and N of 1J5	26V ac 400 Hz.		Check continuity from pins H, J, and N of 1J5 to pin 4 of A1. If zero ohms but no voltage, replace A1.
Grd	Pin S of A4	28V dc		Check continuity from pin S of A4 to pin 1 of L1. Check voltage at IN of L1. This should be 28V dc.
Grd	Pin S of A5	28V dc		Check continuity from pin S of A5 to pin 2 of L1. Check voltage at IN of L1. This should be 28V dc.
Grd	Pin S of A6	28V dc		Check continuity from pin S of A6 to pin 3 of L1. Check voltage at IN of L1. This should be 28V dc.
	With K1 removed from socket.			
Grd	Pin 7 of 1J6		Zero Ω	Check continuity to grd. bus.
Grd	Pin 3 of 1J6	Approximately 38v dc.		Check C1, R2, and CR2.
	Pulse generator removed.			
	Pin NP of 1J7			Check wiring.
	Pin PP	Continuity to pin H of A4, A5, and A6.		Check wiring.
Grd	Pin 115 of 1J7 (pulse module)	115V ac 400 Hz.		Check continuity from pin 115 of 1J7 to pin R of 1J1. Check resistance of pin 3 to pin 1 of A1. Resistance should be 7.6 (power off).
Grd	Pin B+ of 1J7	+20V dc		Check R1 (36 ohms). Check continuity E4 to pin h of 1J1. Check CR1.
	Complete SAU operation, test box and extender card. Control channel connector Pin:			Refer to paragraph 6-16 for troubleshooting.

Neg. lead from	Point of measurement positive lead	Normal indication: Voltage	Normal indication: Voltage-off resistance	Isolating procedure
	A	Open.		
	B	Grd.		
	C	+28V when NO GO light is on.		
	D	+28V.		
	E	See figure 5-10, view A, for 11-16V dc when CC assembly is balanced.		Valve driver output at pin 1.
	F	Negative pulse (para 5-30*b*)		Pulse generator and associated circuitry.
	H	Positive pulse (para 5-30*b*)		Pulse generator and associated circuitry.
	J	Ground on roll and yaw, 3-4V dc on pitch.		
	K	Grd.		
	L	Approximately 10V dc and output of gyro (200 mv peak/deg/sec).		Control or gyro circuitry control.
	M	Approximately 11V dc.		
	N	Open.		
	P	10V dc and output of gyro (200 mv peak/deg/sec).		Control or gyro circuitry.
	R	In-phase for clockwise motion on feedback knob. Out of phase for counterclockwise motion on feedback knob.		Feedback information.
	S	28V dc.		
	T	See figure 5-10, view B		Valve driver output.
	U	Ope.		
	V	Open.		

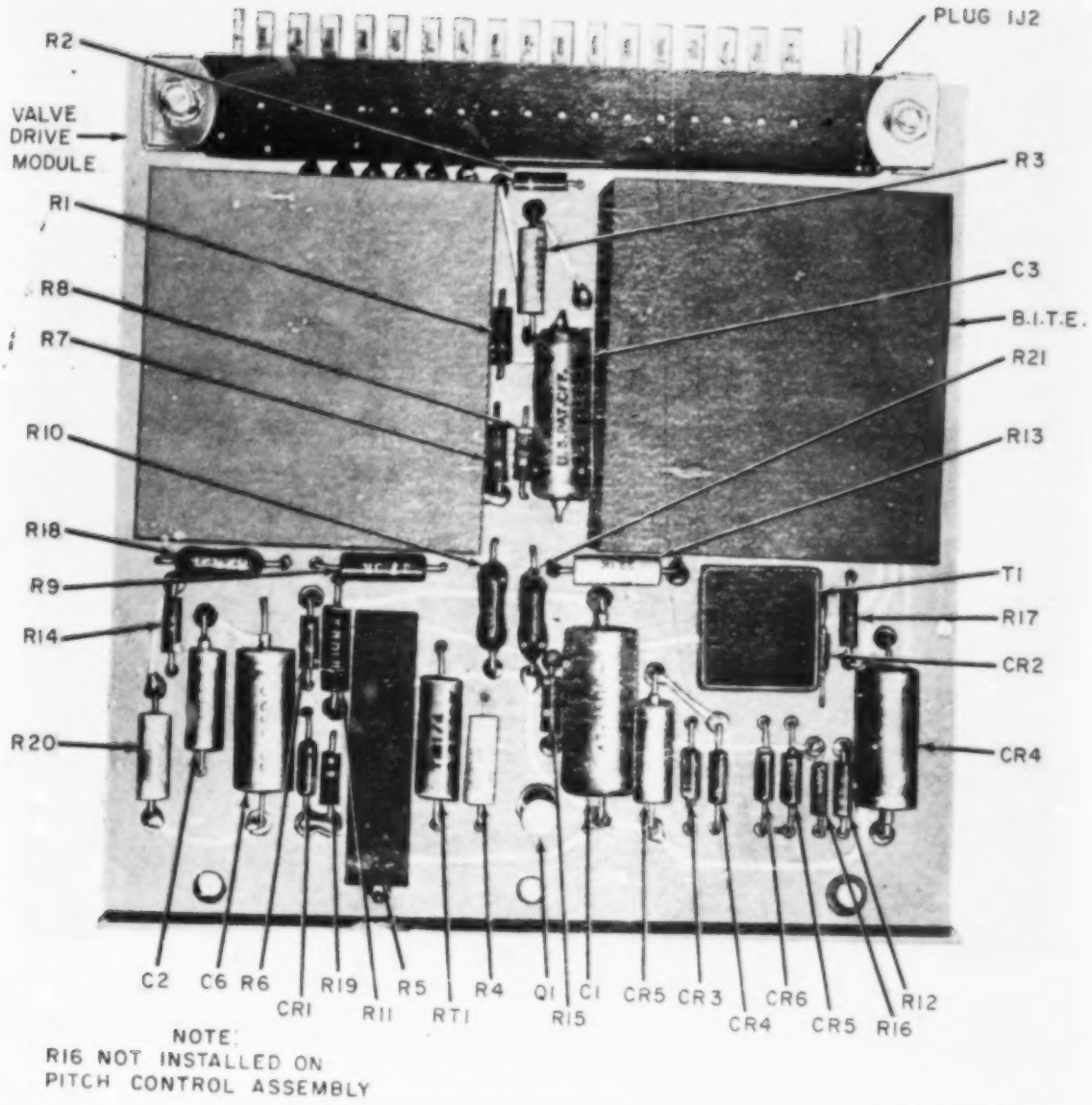

Figure 5-17. SCAS control channel assembly module (front).

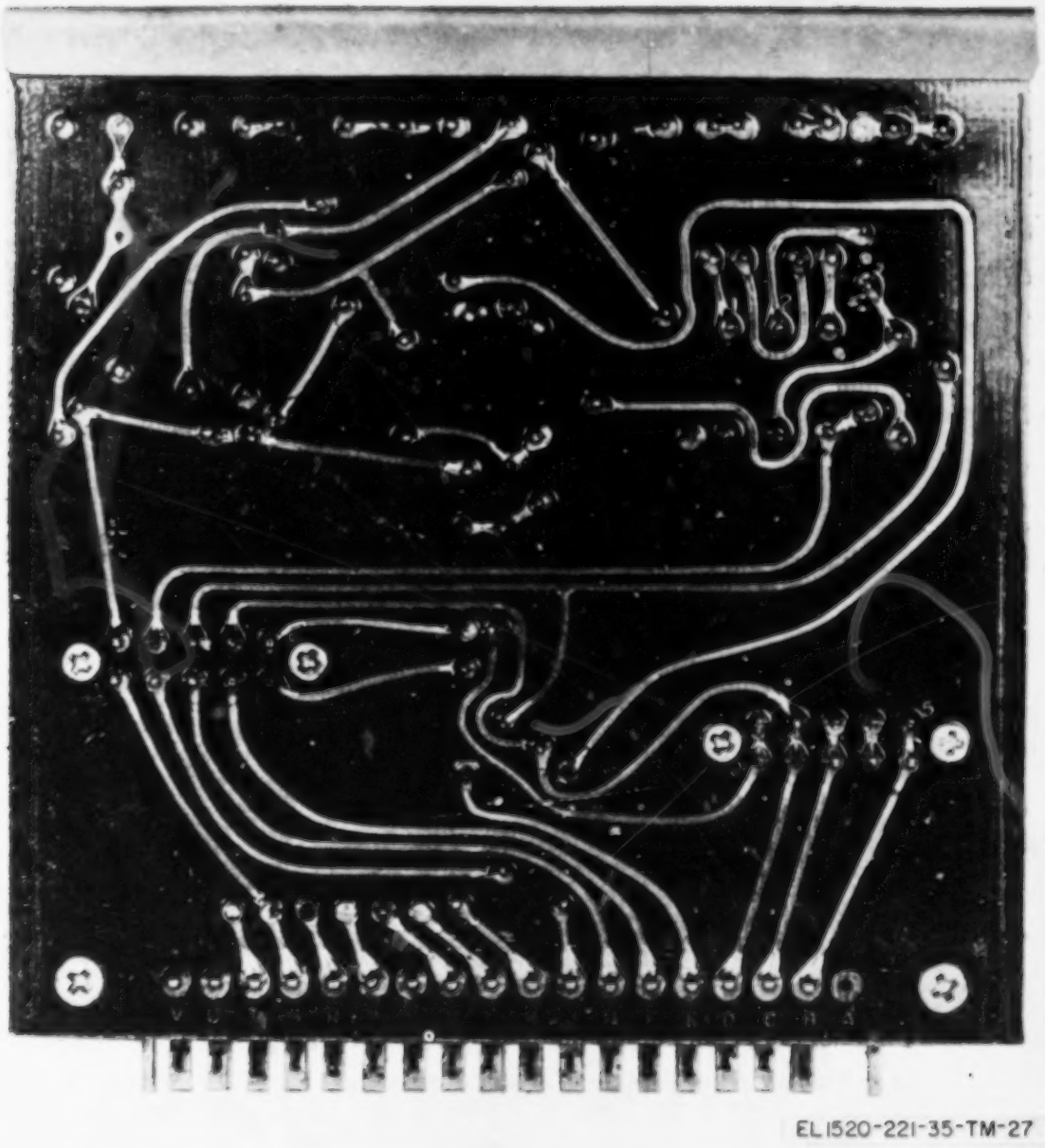

Figure 5-18. SCAS control channel assembly module (rear).

Section IV. PERFORMANCE TESTING AND STANDARDS

5-32. General

a. The testing procedures in this section are prepared for use by maintenance shops and supporting organizations responsible for performing maintenance of the stability augmentation system. These procedures set forth specific requirements that the repaired SCAS control panel, sensor amplifier unit and control channel assemblies must meet before they are returned to the using organization.

b. Comply with the instructions preceding the body of each chart before performing the procedures in the chart. When new or fully repaired components are being tested, perform each test for the particular component in the sequence given. *Do not vary the sequence.* For each step, perform all the actions in the *Control settings* column, then perform each specific test procedure, and verify the results against the data given in the *Performance standard* column.

5–33. Test Equipment

Test equipment and other equipment required to perform the testing procedures in this chapter are listed in paragraph 5–21.

5-34. Control Panel Bench Test

a. Test Equipment and Materials. (Refer to paragraph 5-21.)

b. Test Connections. Connect the equipment as shown in figure 5-11.

c. Procedures.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	DC POWER switch: OFF. AC POWER switch: OFF. MODE selector: CP. CHANNEL selector: PITCH.	POWER switch (2S1): OFF.	a. Set AC and DC POWER switches of the test set to AC and DC position.	a. Edge-lit panel lights come on. All control panel markings are clearly visible and uniformly lighted, no visible light leakage at panel junctions, and no visible light leakage because of panel flaws on surfaces or edges.
			b. Set 2S1-POWER switch on the control panel to POWER.	b. AC and DC indicator lights on the test set come on and will stay on throughout the test except as specifically stated in this test.
			c. Depress momentarily each NO GO indicator light on the control panel.	c. All NO GO indicator lights on the control panel come on.
			d. Depress NO GO TEST pushbutton switch on the test set.	d. All NO GO lights on control panel and NO GO light on test set come on and stay as long as the NO GO TEST switch is depressed.
			e. Set PITCH engage switch 2S2 to up position.	e. ENGAGED indicator light on the test set comes on.
			f. Set CHANNEL selector to ROLL	f. ENGAGED light goes out. PITCH engage switch 2S2 stay up (engaged).
			g. Set ROLL engage switch 2S3 to up (engaged) position.	g. ENGAGED light on the test set comes on.
			h. Set CHANNEL selector to YAW	h. ENGAGED light goes out. PITCH 2S2 and ROLL 2S3 remain engaged.
			i. Set YAW engage switch S24 to up (engaged) position.	i. ENGAGED light on the test set comes on.
			j. Depress momentarily the EMER DISENGAGE switch on the test set.	j. PITCH 2S2, ROLL 2S3 and YAW 2S4 engage switches immediately move to OFF. The ENGAGED light on the test set goes out.

5-35. Sensor Amplifier Unit Bench Test

a. Test Equipment and Materials. (Refer to paragraph 5-21.)

b. Test Connections. Connect the equipment as shown in figure 5-13 and open sensor amplifier unit access door to expose control channel assemblies.

c. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	DC POWER switch: OFF.		a. Connect voltmeter to the test set as follows:	a. None.

AC POWER switch: OFF. MODE selector: SAU. CHANNEL selector: PITCH.	Positive lead (Red) to TP1. Ground lead (Black) to TP2.	
	b. Set voltmeter to 10V scale.	*b.* None.
	c. Connect multimeter to the test set as follows: Positive lead (Red) to TP5. Ground lead (Black) to GRD.	*c.* None.
	d. Set multimeter to .1 scale.	*d.* None.
	e. Set AC and DC switches on the test set to AC and DC.	*e.* AC and DC indicator lights on the test set come on. NO GO amplifier unit and on the test set come on and then go out within one minute.
	f. Adjust FEEDBACK knob to obtain null indication on the multimeter.	*f.* None.
	g. Remove multimeter.	*g.* None.
	h. Adjust R5 potentiometer in the PITCH control channel assembly (BHC 570-074-037-7) to obtain 0 indication on the voltmeter.	*h.* None.
	i. Set CHANNEL selector on the test set to ROLL.	*i.* None.
	j. Adjust R 5 potentiometer in the ROLL control channel assembly (BHC 570-974-037-15) to obtain a 0 indication on the voltmeter.	*j.* None.
	k. Set CHANNEL selector on the test set to YAW.	*k.* None.
	l. Adjust R5 potentiometer in the YAW control channel assembly (BHC 570-074-037-11) to obtain 0 indication on the voltmeter.	*l.* None.
	m. Set CHANNEL selector on the test set to PITCH.	*m.* None.
	n. Connect voltmeter same as *a* and *b* above.	*n.* None.
	o. Slowly raise rear of sensor amplifier unit to produce an angular motion of the sensor amplifier unit.	*o.* Voltmeter indicates positive voltage during motion.
	p. Lower rear of sensor amplifier unit to original position.	*p.* None.
	q. Rotate FEEDBACK knob clockwise until multimeter indicates 0.5 volt.	*q.* Voltmeter indicates 3.1 ± 0.9 volts for pitch, 4.0 ± 1.2 volts for roll, 7.0 ± 2.1 volts for yaw.
	r. Set FEEDBACK knob to 0, then rotate knob clockwise until NO GO light lights.	*r.* Voltmeter indicates 6.0 ± 2 volts.
	s. Reverse voltmeter polarity.	*s.* None.
	t. Rotate FEEDBACK knob counterclockwise until multimeter indicates 0.5 volt.	*t.* Voltmeter indicates 3.1 ± 0.9 volts for pitch, 4.0 ± 1.2 volts for roll, 7.0 ± 2.1 for yaw.
	u. Set FEEDBACK knob to 0, then rotate knob counterclockwise until NO GO light lights.	*u.* Voltmeter indicates 6.0 ± 2 volts.

Step No.	Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			v. Depress and hold ACTR TEST switch 1S2 on, on sensor amplifier unit.	*v.* NO GO light on test and NO GO indicator light in sensor amplifier unit go out.
			w. Release ACTR TEST switch 1S2	*w.* NO GO light on test set and NO GO indicator light in sensor amplifier unit come on.
			x. Adjust FEEDBACK knob to obtain 0 indication on voltmeter.	*x.* None.
			y. Remove voltmeter	*y.* None.
			z. Connect signal generator to TP3 and TP4 on the test set.	*z.* None.
			Caution: Do no ground TP3 or TP4. DC bias is present on TP4.	
			aa. Set oscilloscope controls as follows: VERTICAL SENSITIVITY: 1 Volt cm. AMPLIFIER INPUT switches: DC. HORIZONTAL SWEEP: .1 millisecond/cm. TRIGGER SOURCE: LINE. *Note.* Use oscilloscope to adjust signal generator output for 10 volts peak-to-peak sine wave signal.	*aa.* None.
			ab. Connect oscilloscope vertical lead to TP1 on the test set.	*ab.* None.
			ac. Adjust signal generator to frequency A as shown in table 5–1.	*ac.* Observe peak-to-peak voltage indication on the oscilloscope. Acceptable performance standard is listed in table 5–1.
			ad. Adjust signal generator to frequency B as shown in table 5–1.	*ad.* Same as *aa* above.
			ae. Adjust signal generator to frequency C as shown in table 5–1.	*ae.* Same as *aa* above.
			af. Remove signal generator	*af.* None.
			ag. Connect voltmeter as in *a* and *b*	*ag.* None.
			ah. Set CHANNEL selector on the test set to ROLL.	*ah.* None.
			ai. Slowly raise left side (when viewed from front) of sensor amplifier unit to produce an angular motion of the sensor amplifier unit.	*ai.* Voltmeter indicates positive voltage during motion.
			aj. Lower left side of sensor amplifier unit to original position.	*aj.* None.
			ak. Repeat *q* through *ag* above to test roll channel.	*ak.* Same as *q* through *ag*.
			al. Set CHA[illegible]ector on the test set to YAW.	*al.* None.
			am. Slowly rotate this sensor amplifier unit counterclockwise.	*am.* Voltmeter indicates positive voltage during motion.

an. Rotate the sensor amplifier unit clockwise to original position.	*an.* None.
ao. Repeat *q* through *ag* above to test yaw channel.	*ao.* Same as *q* through *ag*.
ap. Connect positive lead of VOM to pin M of TJ2 on Test Set; connect negative lead of VOM to ground.	*ap.* VOM should indicate 27.5±2.0 volts.
aq. Set AC POWER switch to OFF	*aq.* VOM indicates 0 volts.

5–36. Control Panel and Sensor Amplifier Unit Bench Test

a. Test Equipment and Materials. (Refer to paragraph 5–21.)

b. Test Connections. Connect the equipment as shown in figure 5–13.

c. Procedures.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	DC POWER switch: OFF. AC POWER switch: OFF. MODE selector: CP/SAU. CHANNEL selector: PITCH.	Control panel POWER (2S1) switch: OFF	*a.* Connect Voltmeter to test set as follows: Positive lead (Red) to TP1. Ground lead (Black) to TP2.	*a.* None.
			b. Set voltmeter to 10V scale	*b.* None.
			c. Set AC to DC EXT POWER switches on the test set to AC and DC.	*c.* Control panel edge lights come on.
			d. Set POWER switch on the control head to POWER.	*d.* PITCH, ROLL, and YAW NO GO lights on the control panel and the NO GO light on the test set come on for approximately 60 seconds and then go out. AC and DC indicator lights on the test set come on. *Note.* The AC and DC indicator lights on the test set will stay on except as specifically stated in this test.
			e. Connect multimeter to the test set as follows. Positive lead (Red): TP5. Negative lead (Black): GRD.	*e.* None.
			f. Set multimeter to .1 volt scale	*f.* None.
			g. Adjust FEEDBACK knob on the test set to obtain null indication on the multimeter.	*g.* None.
			h. Adjust R5 potentiometer in the PITCH control channel assembly of sensor amplifier unit to obtain 0 indication on the voltmeter.	*h.* None.
			i. Set CHANNEL selector on the test set to ROLL.	*i.* None.
			j. Repeat h above	*j.* None.
			k. Set CHANNEL selector on the test set to YAW.	*k.* None.
			l. Repeat h above	*l.* None.

Step No.	Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			m. Set PITCH, ROLL, and YAW engage switches on the control panel to up (engaged) position.	*m.* ENGAGED light on the test set comes on. PITCH, ROLL, and YAW engage switches remain engaged.
			n. Set CHANNEL selector on the test set to ROLL.	*n.* PITCH, ROLL, and YAW engage switches on control panel remain engaged. ENGAGED light on the test set stays on.
			Note. When the CHANNEL selector on the test set is rotated to a new position, the NO GO light on the test set may come on for a few seconds and then go out. If any of the engage switches on the control panel are not engaged the appropriate NO GO light may illuminate.	
			o. Set CHANNEL selector on the test set to PITCH.	*o.* PITCH, ROLL, and YAW engage switches on the control panel remain engaged. ENGAGED light on the test set stays on.
			p. Depress momentarily the EMER DISENGAGE switch on the test set.	*p.* PITCH, ROLL, and YAW engage switches immediately move to OFF. ENGAGED light on the test set goes out.
			q. Set PITCH, ROLL, and YAW switches on the control panel to engaged position.	*q.* Engage switches hold in engaged position. ENGAGED light on the test set comes on.
			r. Set AC switch on the test set to OFF	*r.* PITCH, ROLL, and YAW engage switches on the control panel immediately move to OFF. ENGAGED and AC lights on the test set go out.
			s. Set AC switch on the test set to AC	*s.* AC light on the test set comes on.
			t. Set PITCH, ROLL, and YAW engage switches on the control panel to engaged position.	*t.* PITCH, ROLL, and YAW engage switches hold in engaged position. ENGAGED light on the test set comes on.
			u. Set POWER switch on control panel to OFF.	*u.* PITCH, ROLL, and YAW engage switches immediately move to OFF. ENGAGED AC and DC lights on the test set go out.
			v. Set POWER switch on the control panel to engaged position.	*v.* NO GO lights on the control panel and test set come on for approximately 60 seconds or less, and then go out. AC and DC indicators on the test set come on.
			w. Adjust FEEDBACK knob on the test set to obtain 0 indication on the voltmeter.	*w.* None.
			x. Slowly raise the aft side of the sensor amplifier unit to produce an angular motion.	*x.* Voltmeter indicates positive voltage.
			y. Return sensor amplifier unit to original position.	*y.* None.
			z. Rotate FEEDBACK knob clockwise until VTVM indicates 0.5 volt.	*z.* Voltmeter indicates 3.1 ± 2.9 volts for pitch, 4.0 ± 1.2 volts for roll, 7.0 ± 2.1 volts for yaw.

aa.	Set FEEDBACK knob to 0, then rotate knob clockwise until NO GO light lights.	*aa.* Voltmeter indicates 6.0 ± 2 volts.
ab.	Set FEEDBACK knob to 0	
ab.	Reverse voltmeter polarity	*ab.* None.
ad.	Rotate FEEDBACK knob counterclockwise until multimeter indicates 0.5 volt.	*ac.* None. *ad.* Voltmeter indicates 3.1 ± 0.9 volts for pitch, 5.0 ± 1.5 volts for roll, 7.0 ± 2.1 volts for yaw.
ae.	Set FEEDBACK knob to 0, then rotate knob counterclockwise until NO GO light lights.	*ae.* Voltmeter indicates 6.0 ± 2 volts.
af.	Depress and hold ACTR TEST switch on the test set.	*af.* NO GO lights go out.
ag.	Release ACTR TEST switch	*ag.* NO GO lights illuminate.
ah.	Adjust FEEDBACK knob to obtain null indication on the voltmeter.	*ah.* None.
ai.	Remove voltmeter	*ai.* None.
aj.	Connect signal generator to TP3 and TP4 on the test set.	*aj.* None.
	Caution: Do not ground TP3 or TP4 DC bias is present on TP4.	
ak.	Set oscilloscope switches as follows: VERTICAL SENSITIVITY: 1 VOLT/CM. AMPLIFIER INPUT switches: DC. HORIZONTAL SWEEP: .1 MILLISECOND/CM. TRIGGER SOURCE: LINE EXT 115 vac, 400 Hz.	*ak.* None.
	Note. Use oscilloscope to adjust signal generator output for 10 volts peak-to-peak sine wave signal.	
al.	Connect oscilloscope vertical lead to TP1 on the test set.	*al.* None.
am.	Adjust signal generator to frequency A as shown in table 5–1.	*am.* Observe peak-to-peak voltage indication on the oscilloscope. Acceptab e performance standard is listed in table 5–1.
an.	Adjust signal generator to frequency B as shown in table 5–1.	*an.* Same as *aj* above.
ao.	Adjust signal generator to frequency C as shown in table 5–1.	*ao.* Same as *aj* above.
ap.	Remove signal generator	*ap.* None.
aq.	Connect voltmeter as in *a* and *b* above. Reverse voltmeter polarity (+dc).	*aq.* None.
ar.	Set CHANNEL selector on the test set to ROLL.	*ar.* None.
as.	Slowly raise left side (when viewed from front) of sensor amplifier unit	*as.* Voltmeter indicates positive voltage during motion.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			to produce an angular motion of the sensor amplifier unit.	
			at. Lower left side of sensor amplifier unit to original position.	*at.* None.
			au. Repeat *z* through *aq* to test roll channel	*au.* Same as *z* through *aq* above.
			av. Set CHANNEL selector on the test set to YAW.	*av.* None.
			aw. Slowly rotate the sensor amplifier unit counterclockwise.	*aw.* Voltmeter indicates positive voltage during motion.
			ax. Return the sensor amplifier unit to original position.	*ax.* None.
			ay. Repeat *z* through *aq* to test yaw channel.	*ay.* Same as *z* through *aq* above.

5–37. Control Channel Assembly Bench Test

a. Test Equipment and Materials. (Refer to paragraph 5–21.)

b. Test Connections. Connect the equipment as shown in figure 5–15 and insert control channel assembly to be tested in TJ4 on the test set.

c. Procedures.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	DC POWER switch: N/A OFF. AC POWER switch: OFF. MODE selector: MOD. CHANNEL selector: PITCH.		*a.* Connect multimeter to test set as follows: Positive lead (Red) to TP5. Ground lead (Black) to GRD.	*a.* None.
			b. Set multimeter to 3V scale	*b.* None.
			c. Connect voltmeter to the test set as follows: Positive lead (Red) to TP1. Ground lead (Black) to TP2.	*c.* None.
			d. Set voltmeter to 10V scale	*d.* None.
			e. Set AC and DC switches on test set to AC and DC.	*e.* AC and DC indicator lights on the test set come on. The NO GO light goes out in less than 60 seconds.
			f. Adjust FEEDBACK knob to obtain null indication on the multimeter.	*f.* None.
			g. Adjust R5 potentiometer on the control channel assembly to obtain o ± .1 volt indication on the voltmeter.	*g.* None.
			h. Rotate FEEDBACK knob clockwise until multimeter indicates 0.5 volt.	*h.* Voltmeter indicates 3.1±0.9 volts for pitch, 4.0±1.2 volts for roll, 7.0±2.1 volts for 3 yaw.
			i. Set FEEDBACK knob to 0, then rotate knob clockwise until NO GO light lights.	*i.* Voltmeter indicates 6.0±2 volts.
			j. Set FEEDBACK knob to 0	*j.* None.

k. Reverse voltmeter polarity	*k.* None.
l. Rotate FEEDBACK knob counterclockwise until multimeter indicates 0.5 volt.	*l.* Voltmeter indicates 3.1±0.9 volts for pitch, 4.0±1.2 volt for roll, 7.0±2.1 volts for yaw.
m. Set FEEDBACK knob to 0, then rotate knob counterclockwise until NO GO light lights.	*m.* Voltmeter indicates 6.0±2 volts.
n. Adjust FEEDBACK knob to obtain null indication on the multimeter.	*n.* None.
o. Remove voltmeter	*o.* None.
p. Connect signal generator to TP3 and TP4 on the test set.	*p.* None.
Caution: Do not ground TP3 or TP4. Dc bias is present on TP4.	
q. Set oscilloscope switches as follows: VERTICAL SENSITIVITY: 1 VOLT/CM. AMPLIFIER INPUT switches: DC. HORIZONTAL SWEEP: .1 MILLISECOND/CM. TRIGGER SOURCE: LINE EXT 115 vac, 400 Hz.	*q.* None.
Note. Use oscilloscope to adjust signal generator output for 10 volts peak-to-peak sine wave signal.	
r. Connect oscilloscope vertical lead to TPI on the test set.	*r.* None.
s. Adjust signal generator to frequency A as shown in table 5–1.	*s.* Observe peak to-peak voltage indication on the oscilloscope. Acceptable performance standard is listed in table 5–1.
t. Adjust signal generator to frequency B as shown in table 5–1.	*t.* Same as *s* above.
u. Adjust signal generator to frequency C as shown in table 5–1.	*u.* Same as *s* above.
v. Remove signal generator	*v.* None.
w. Connect signal generator to TP6 and GRD on the test set.	*w.* None.
x. Position AC and DC power switches to OFF.	*x.* None.
y. Remove assembly under test from TJ4	*y.* None.
z. Insert 570–091–011–1 extender card into TJ4.	*z.* None.
aa. Set osc switches as follows: VERTICAL SENSITIVITY: 0.1 volts/cm. AMPLIFIER INPUT SWITCHES: DC. HORIZONTAL SWEEP: 5msec/cm. TRIGGER SOURCE: EXT 115 vac,	*aa.* None.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			400 Hz.	
			ab. Connect Osc input leads to pins P and L on extender card.	*ab.* None.
			ac. Position AC and DC power switches to AC and DC.	*ac.* None.
			ad. Adjust amplitude of signal generator to obtain 0.2 volts peak-to-peak modulation envelope.	*ad.* Osc should indicate 0.2 volts peak-to-peak.
			ae. Position AC and DC power switches to OFF.	*ae.* None.
			af. Remove extender card and insert control assembly in TJ4.	*af.* None.
			ag. Set osc switches as follows: VERTICAL SENSITIVITY. 0.2 volt/cm. AMPLIFIER INPUT SWITCHES: DC. HORIZONTAL SWEEP: 0.1 m/sec/cm. TRIGGER SOURCE: EXT 115 vac, 400 Hz.	*ag.* None.
			ah. Connect osc vertical to TP1	*ah.* None.
			ai. Position AC and DC switches to AC and DC.	*ai.* None.
			aj. Adjust frequency of signal generator to frequency A in table 5-2.	*aj.* Observe peak-to-peak indication on osc. Performance standard is listed in table 5-2.
			ak. Adjust frequency of signal generator to frequency B in table 5-2.	*ak.* Observe peak-to-peak indication on osc. Performance standard is listed in table 5-2.
			al. Adjusts frequency of signal generator C to table 5-2.	*al.* Observe peak-to-peak indication on osc. Performance standard is listed in table 5-2.

5-38. Pylon Compensation Unit Bench Test

a. Test Equipment and Materials. (Refer to paragraph 5-21.)

b. Test connections. Connect the equipment as shown in figure 5-6.

c. Procedures.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	DC POWER switch: OFF. AC POWER switch: OFF.		*a.* Connect voltmeter positive lead to TP8 and negative lead to GRD on test set. Set voltmeter on 50 VDC scale.	*a.* None.
			b. Energize external power source	*b.* None.

Note. Position of other controls may be anywhere for this test.	
c. Position DC power switch to DC	*c.* Voltmeter indicates 10±1 volts.
d. Connect voltmeter positive lead to TP10 on test set.	*d.* Voltmeter indicates 10±1 volts.
e. Disconnect voltmeter	*e.* None.
f. Set osc as follows: VERTICAL SENSITIVITY: 1 volt/cm. AMPLIFIER INPUT SWITCHES: DC. HORIZONTAL SWEEP: 0.1 m/sec/cm. TRIGGER SOURCE: EXT 115 vac, Hz.	*f.* None.
g. Using osc adjust signal generator to a 1.0 Hz sine wave output with a peak-to-peak amplitude of 3.0 volts.	*g.* None.
h. Connect generator output to TP8 and TP9 of test set. *Caution:* Do not ground TP8 or TP9. DC bias is present on TP8.	*h.* None.
i. Set vertical sensitivity on osc to 10 millivolts/cm.	*i.* None.
j. Connect vertical input of osc to TP7 of the test set. *Note.* Potentiometer R5 should be set to the full clockwise position.	*j.* Osc should indicate 40±15 millivolts peak-to-peak.
k. Set vertical sensitivity on osc to 20 millivolts/cm.	*k.* None.
l. Adjust signal generator to 2.5 Hz	*l.* Osc should indicate 130±20 millivolts peak-to-peak.
m. Set vertical sensitivity on osc to 50 millivolts/cm.	*m.* None.
n. Adjust signal generator to 4.0 Hz	*n.* Osc should indicate 200±30 millivolts peak-to peak.
o. Adjust signal generator to 8.0 Hz	*o.* Osc should indicate 180±50 millivolts peak-to-peak.
p. Set vertical sensitivity on osc to 5 millivolts/cm.	*p.* None.
q. Adjust signal generator output frequency to obtain a null on the osc.	*q.* Null frequency should be 11±1 Hz.
r. Set vertical sensitivity on osc to 0.1 volts/cm.	*r.* None.
s. Adjust generator to 20 Hz	*s.* Osc. should indicate 650±90 millivolts peak-to-peak.
t. Set vertical sensitivity on osc to 0.2 volts/cm.	*t.* None.
u. Adjust generator to 40.0 Hz	*u.* Osc should indicate 1.5±0.2 volts peak-to-peak.

CHAPTER 6

PROXIMITY WARNING FACILITY

SECTION I. INTRODUCTION

6-1. Scope.

a. This chapter covers direct and general support and depot maintenance of the Proximity Warning Facility YG-1054 for use with Model AH-1G and TH-1G helicopters Serial Numbers 66-15249 through 66-15357, 67-15450 through 67-15869, 68-15000 through 68-15213, 68-17020 through 68-17113, 68-16410 through 69-16447 and 70-15936 through 70-16105. This chapter includes instructions appropriate to direct support maintenance personnel for performance of periodic inspections and for troubleshooting the proximity warning facility when installed in the helicopter.

b. Bench maintenance of the proximity warning facility is covered in a separate technical manual.

c. Block diagram analysis is contained in TM 11-1520-221-20. Analysis of the electronic configuration interunit circuits is covered in paragraph 6-3 of this chapter. For detailed circuit analysis and block diagram of the proximity warning facility refer to the operating/service manual.

6-2. Electronic Configuration

The proximity warning facility can be used with configuration A through D starting with aircraft serial number 66-15249 after MWO 55-1520-221-30-49.

6-3. PROXIMITY WARNING FACILITY YG-1054 CONFIGURATIONS A, B, C AND D.
(fig. FO-15)

a. Power Distribution. Primary power (+28-volt dc) for the proximity warning facility, YG-1054 Receiver-Transponder is supplied through circuit breaker PROX. WARN. With PROX. WARN. circuit breaker depressed, +28-volts dc is applied to pin A of J8010 at Receiver-Transponder YG-1054. Panel lighting for the Receiver-Transponder (+28-volt dc) is routed from terminal 3 of terminal board TB6 to pin C of J8010 at the Receiver-Transponder.

b. Audio Distribution. Audio signals from the proximity warning facility are routed to the intercommunications system as follows: Audio signals from the proximity warning facility are coupled through pin F of J8010 and P8010 to F.S. 115. At F.S. 115 cut wires, SX803B22 and SX803C22, and attach wire PWD-3A22 to wire SX803C22 through a 16,000 ohm resistor. Also, attach wire PWD-4A22 to wire SX803B22 through a second 16,000 ohm resistor. The 16,000 ohm resistors serve as isolation resistor between the AN/APX-72 audio and the proximity warning facility audio. No change is made in the AN/APX-72 audio wiring.

SECTION III. DIRECT SUPPORT MAINTENANCE

6-4. General Instructions.

The direct support maintenance procedures in this chapter supplement the organizational maintenance procedures in TM 11-1520-221-20. These procedures also supplement the operating and service instructions. The proximity warning facility maintenance procedures begin with the functional operation and sectionalization checks which can be performed by organizational and direct support maintenance personnel within the helicopter and are extended to removal and replacement of units or components from the helicopter. When the components are removed

from the helicopter, the systematic maintenance procedures continue with the bench maintenance of the individual electronic equipment components. Paragraph 6-7 of this chapter provides direct support troubleshooting and repair of the proximity warning facility installation within the helicopter and supplement the organizational maintenance procedures.

6-5. Troubleshooting Procedures.

a. General. Troubleshooting the proximity warning facility in Army Model AH-1G and TH-1G helicopters is performed to localize the trouble to the defective unit that is part of the system and/or associated junction box, terminal boards, cabling or wiring.

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work and to aid in tracing troubles to the defective facility.

(1) *Visual Inspection.* Visual inspection is used to locate faults before operating or testing circuits. The seating of all component connectors, bent pins, connections to switches and circuit breakers, connections on terminal boards, connections to antennae, chafing, etc., should be observed and an attempt made to locate the fault.

(2) *Operational Tests.* Operational tests as outlined in TM 11-1520-221-20 will help in determining the exact nature of the fault.

c. Localization. The procedures listed below are used for localizing troubles within the proximity warning facility to the faulty component or unit.

(1) *Performance Tests.* The periodic preventive maintenance checks and services chart test (TM 11-1520-221-20) are used on conjunction with the troubleshooting charts to locate faulty items.

(2) *Troubleshooting Chart.* The troubleshooting chart will aid in localizing the trouble. If the corrective measures indicated do not restore normal equipment operation, troubleshooting the cabling circuits may be necessary. When the trouble is isolated to an installed item, remove the item from the helicopter and replace it with an installation item known to be in working order. When the trouble is isolated to the proximity warning facility receiver-transponder, remove the receiver-transponder for bench testing and replace it with one known to be in good working order. Note on the repair tag how the equipment performed and what corrective measures were taken.

(3) *Intermittent Troubles.* In all tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment and checking wiring and connections to the components.

d. Isolation. After the trouble has been localized (c) above, the methods described in the proximity warning facility operation and service manual will aid in isolating the trouble to a defective circuit element within a component.

6-6. Test Equipment and Tools Required.

The test equipment and tools required for troubleshooting the proximity warning facility as installed in AH-1G and TH-1G Model Helicopters are listed in TM 11-1520-221-20.

6-7. Troubleshooting Proximity Warning Facility YG-1054 (Configuration A through D).

a. Facility Performance Test. Refer to TM 11-1520-221-20 for performance test.

b. Proximity Warning Facility YG-1054 Troubleshooting Chart (Configuration A, B, C, and D).

Symptom	*Probable Trouble*	*Corrective Measures*
Control panel lamps do not light when helicopter primary power switch is set to ON.	Panel lamps loose in sockets or burned out.	Check panel lamps for proper seating and replace if necessary.

Symptom	*Probable Trouble*	*Corrective Measures*
PROX WARN circuit breaker opens with receiver-transponder is turned on.	Primary power is shorted in wiring from circuit breaker or receiver-transponder.	Disconnect receiver-transponder, depress breaker. If breaker does not trip, replace receiver-transponder. If breaker trips, check out primary wiring.
Receiver-transponder ABOVE, EQUAL and BELOW lamps do not light when CONFIDENCE TEST switch is ON.	a. Panel lamps defective. b. Receiver-transponder defective.	a. Replace panel lamps. b. Replace receiver-transponder.
Receiver-transponder ABOVE, EQUAL and BELOW lamp cycle when CONFIDENCE TEST switch is ON but audio alarm is not heard in headset.	a. Audio line from receiver-transponder open or shorted. b. Receiver-transponder defective.	a. Check audio lines from receiver-transponder. b. Replace receiver-transponder.
Continuous alarm or no alarm.	Defective receiver-transponder (digital/display module).	Replace receiver-transponder.

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APPENDIX A
REFERENCES

Following is a list of references applicable and available to direct and general support and depot maintenance personnel for the Army Model AH-1G and AH-1Q tactical helicopters.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders.
TB SIG 291	Safety Measures to be Observed When Installing and Using Whip Antennas, Field Type Masts, Towers, Antennas and Metal Poles That are Used With Communication, Radar, and Direction Finder Equipment.
TM 55-1500-323-25	Organizational, DS, GS, and Depot Maintenance Manual: Installation Practices for Aircraft Electric and Electronic Wiring.
TM 11-1520-221-20	Organizational Maintenance Manual: Electronic Equipment Configuration Army, Model AH-1G and AH-1Q Helicopters.
TM 11-1520-221-34P	Direct Support and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools): Helicopter, Attack, AH-1G (Bell).
TM 11-5820-518-35	DS, GS, and Depot Maintenance Manual: Radio Sets AN/ARC-51X and AN/ARC-51BX.
TM 11-5821-244-34	Direct Support and General Support Maintenance Manual: Radio Set AN/ARC-54 (NSN 5821-00-082-3598).
TM 11-5826-225-35	DS, GS, and Depot Maintenance Manual: Direction Finder Set AN/ARN-83.
TM 11-5895-217-35	DS, GS, and Depot Maintenance Manual Including Repair Parts List: Transponder Sets AN/APX-44 and AN/APX-44B.
TM 11-5965-215-15	Operator, Organizational, Field and Depot Maintenance Manual: Headset-Microphone H-101A/U.
TM 11-5965-240-15	Operator, Organizational, Field and Depot Maintenance Manual: Adapter, Headset-Microphone MX-1646/AIC.
TM 11-6605-202-35	DS, GS, and Depot Maintenance Manual: Gyromagnetic Compass Set AN/ASN-43.
TM 11-6625-446-15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Wattmeter AN/URM-120.
TM 11-6625-1704-15	Operator, Organizational, DS, GS and Depot Maintenance Manual Including Repair Parts and Special Tool Lists: Test Set Electronic System AN/ASN-338.
TM 11-6625-203-12	Operator and Organizational Maintenance Manual: Multimeters AN/URM-105 and AN/URM-105C Including Multimeters ME-77/U and ME-77C/U.
TM 11-6625-320-12	Operator and Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U, ME-30C/U, and ME-30E/U.
TM 9-6625-2362-12	Operator's Manual: Oscilloscope AN/USM-281.
TM 11-6625-1703-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tool Lists: Oscilloscope AN/USM-281A.
TM 11-6625-399-12	Operator and Organizational Maintenance Manual: Generator, Signal SG-298/U.

GLOSSARY

Section I. ABBREVIATIONS

att	Attitude
bat.	Battery
int	Interphone
invtr	Inverter
max.	Maximum
nav	Navigation
noness	Nonessential
osc	Oscilloscope
squel	Squelch
vol	Volume
xmit/rec	Transmit-receive
xmtr	Transmitter
B.I.T.E.	Built-in test equipment

Section II. DEFINITIONS OF UNUSUAL TERMS

Basic signal electronic equipment—Equipment for which the US Army Electronics Command has logistic and maintenance responsibility and for which there are DA Publications covering troubleshooting, testing, aligning, and repairing of the equipment through replacing maintenance parts and repairing specific maintenance parts. These equipments are used without modification in more than one aircraft, and are Government-furnished to the aircraft manufacturer for installation.

Configuration—An all-inclusive term that encompasses all the electronic equipments that are installed in the aircraft regardless of their function or use.

Facility—A major subdivision of a system that groups component equipments that are interrelated to perform a unit function or service, such as interphone and audio, uhf command, fm liaison, and others.

Hot mike—Microphone always on (no push-to-talk function).

Sidetone—Part of a signal originating from the transmitter portion of a headset-microphone that is returned to the receiver portion of the same headset-microphone for monitoring communications.

System—A major subdivision of a configuration that groups like facilities, for instance, communication, navigation, instrumentation, and others.

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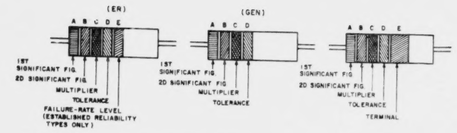


COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS.

COLOR-CODE MARKING FOR FILM-TYPE RESISTORS.

TABLE I
COLOR CODE FOR COMPOSITION TYPE AND FILM TYPE RESISTORS

BAND A		BAND B		BAND C		BAND D		BAND E	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)	COLOR	FAILURE RATE LEVEL / TERM.
BLACK	0	BLACK	0	BLACK	1				
BROWN	1	BROWN	1	BROWN	10			BROWN	M
RED	2	RED	2	RED	100			RED	P
ORANGE	3	ORANGE	3	ORANGE	1,000			ORANGE	R
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	±10 (COMP. TYPE ONLY)	YELLOW	S
GREEN	5	GREEN	5	GREEN	100,000	GOLD	±5	WHITE	SOLDERABLE
BLUE	6	BLUE	6	BLUE	1,000,000	RED	±2 (NOT APPLICABLE TO ESTABLISHED RELIABILITY)		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7						
GRAY	8	GRAY	8	SILVER	.01				
WHITE	9	WHITE	9	GOLD	0.1				

BAND A — THE FIRST SIGNIFICANT FIGURE OF THE RESISTANCE VALUE. (BANDS A THRU D SHALL BE OF EQUAL WIDTH.)

BAND B — THE SECOND SIGNIFICANT FIGURE OF THE RESISTANCE VALUE.

BAND C — THE MULTIPLIER (THE MULTIPLIER IS THE FACTOR BY WHICH THE TWO SIGNIFICANT FIGURES ARE MULTIPLIED TO YIELD THE NOMINAL RESISTANCE VALUE.)

BAND D — THE RESISTANCE TOLERANCE.

BAND E — WHEN USED ON COMPOSITION RESISTORS, BAND E INDICATES ESTABLISHED RELIABILITY FAILURE-RATE LEVEL. ON FILM RESISTORS, THIS BAND SHALL BE APPROXIMATELY 1-1/2 TIMES THE WIDTH OF OTHER BANDS, AND INDICATES TYPE OF TERMINAL.

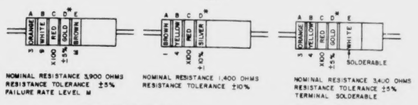
RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS (THESE ARE NOT COLOR CODED.)

SOME RESISTORS ARE IDENTIFIED BY THREE OR FOUR DIGIT ALPHA NUMERIC DESIGNATORS. THE LETTER R IS USED IN PLACE OF A DECIMAL POINT WHEN FRACTIONAL VALUES OF AN OHM ARE EXPRESSED. FOR EXAMPLE:

2R7 = 2.7 OHMS 10R0 = 10.0 OHMS

FOR WIRE-WOUND-TYPE RESISTORS, COLOR CODING IS NOT USED. IDENTIFICATION MARKING IS SPECIFIED IN EACH OF THE APPLICABLE SPECIFICATIONS.

EXAMPLES OF COLOR CODING



NOMINAL RESISTANCE 3,900 OHMS
RESISTANCE TOLERANCE ±1%
FAILURE RATE LEVEL M

COMPOSITION-TYPE RESISTORS

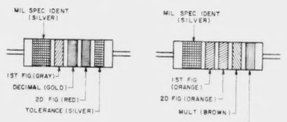
NOMINAL RESISTANCE 3,400 OHMS
RESISTANCE TOLERANCE ±10%

NOMINAL RESISTANCE 3,4K0 OHMS
RESISTANCE TOLERANCE ±5%
TERMINAL SOLDERABLE

FILM-TYPE RESISTORS

* IF BAND D IS OMITTED, THE RESISTOR TOLERANCE IS ±20% AND THE RESISTOR IS NOT MIL-STD.

A. COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS.



COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES. AT A, AN EXAMPLE OF THE CODING FOR AN 82UH CHOKE IS GIVEN. AT B, THE COLOR BANDS FOR A 330 UH INDUCTOR ARE ILLUSTRATED.

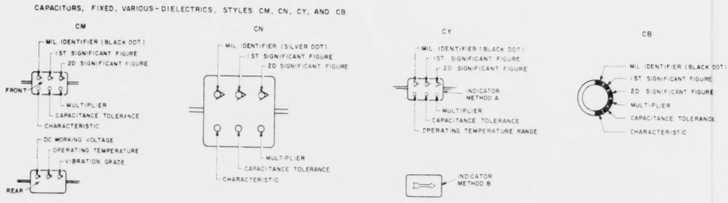
TABLE 2
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES

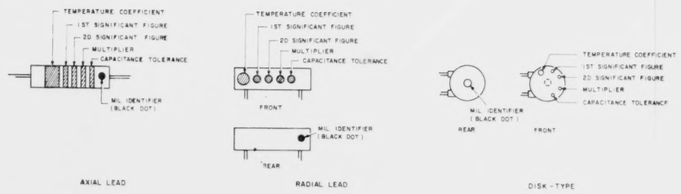
COLOR	SIGNIFICANT FIGURE	MULTIPLIER	INDUCTANCE TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	1
RED	2	100	2
ORANGE	3	1,000	3
YELLOW	4		
GREEN	5		
BLUE	6		
VIOLET	7		
GRAY	8		
WHITE	9		
NONE			20
SILVER			10
GOLD	DECIMAL POINT		5

MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL.

B. COLOR CODE MARKING FOR MILITARY STANDARD INDUCTORS.

CAPACITORS, FIXED, VARIOUS-DIELECTRICS, STYLES CM, CN, CY, AND CB





C. COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS.

TABLE 3 — FOR USE WITH STYLES CM, CN, CY AND CB

COLOR	MIL ID	1ST SIG FIG	2D SIG FIG	MULTIPLIER	CAPACITANCE TOLERANCE CM	CN	CY	CB	CHARACTERISTIC CM	CN	CB	DC WORKING VOLTAGE CM	OPERATING TEMP. RANGE CY, CM	VIBRATION GRADE CM
BLACK	CM, CY, CB	0	0	1			±20%	±20%		A			55°C to +70°C	10-58 c/s
BROWN		1	1	10						B	E	B		
RED		2	2	100	±2%		±2%	±2%	C				-55°C to +85°C	
ORANGE		3	3	1,000		±30%				D		D	300	
YELLOW		4	4	10,000						E			-55°C to +125°C	10-2,000 c/s
GREEN		5	5		±5%					F			500	
BLUE		6	6										-55°C to +150°C	
PURPLE (VIOLET)		7	7											
GREY		8	8											
WHITE		9	9											
GOLD				0.1			±5%	±5%						
SILVER	CN				±10%	±30%	±10%	±10%						

TABLE 4 — TEMPERATURE COMPENSATING, STYLE CC

COLOR	TEMPERATURE COEFFICIENT	1ST SIG FIG	2D SIG FIG	MULTIPLIER	CAPACITANCE TOLERANCE CAPACITANCES OVER 10 UUF	CAPACITANCES 10 UUF OR LESS	MIL ID
BLACK	0	0	0	1		±2.0 UUF	CC
BROWN	-30	1	1	10	±1%		
RED	-80	2	2	100	±2%	±0.25 UUF	
ORANGE	-150	3	3	1,000			
YELLOW	-220	4	4				
GREEN	-330	5	5		±5%	±0.5 UUF	
BLUE	-470	6	6				
PURPLE (VIOLET)	-750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	±10%		
GOLD	+100					±1.0 UUF	
SILVER							

1. THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF.
2. LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS: MIL-C-5, MIL-C-250, MIL-C-11272B, AND MIL-C-10950C RESPECTIVELY.
3. LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11015D.
4. TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE.

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Figure FO-1. MIL STD resistor and capacitor color code markings.

best copy available

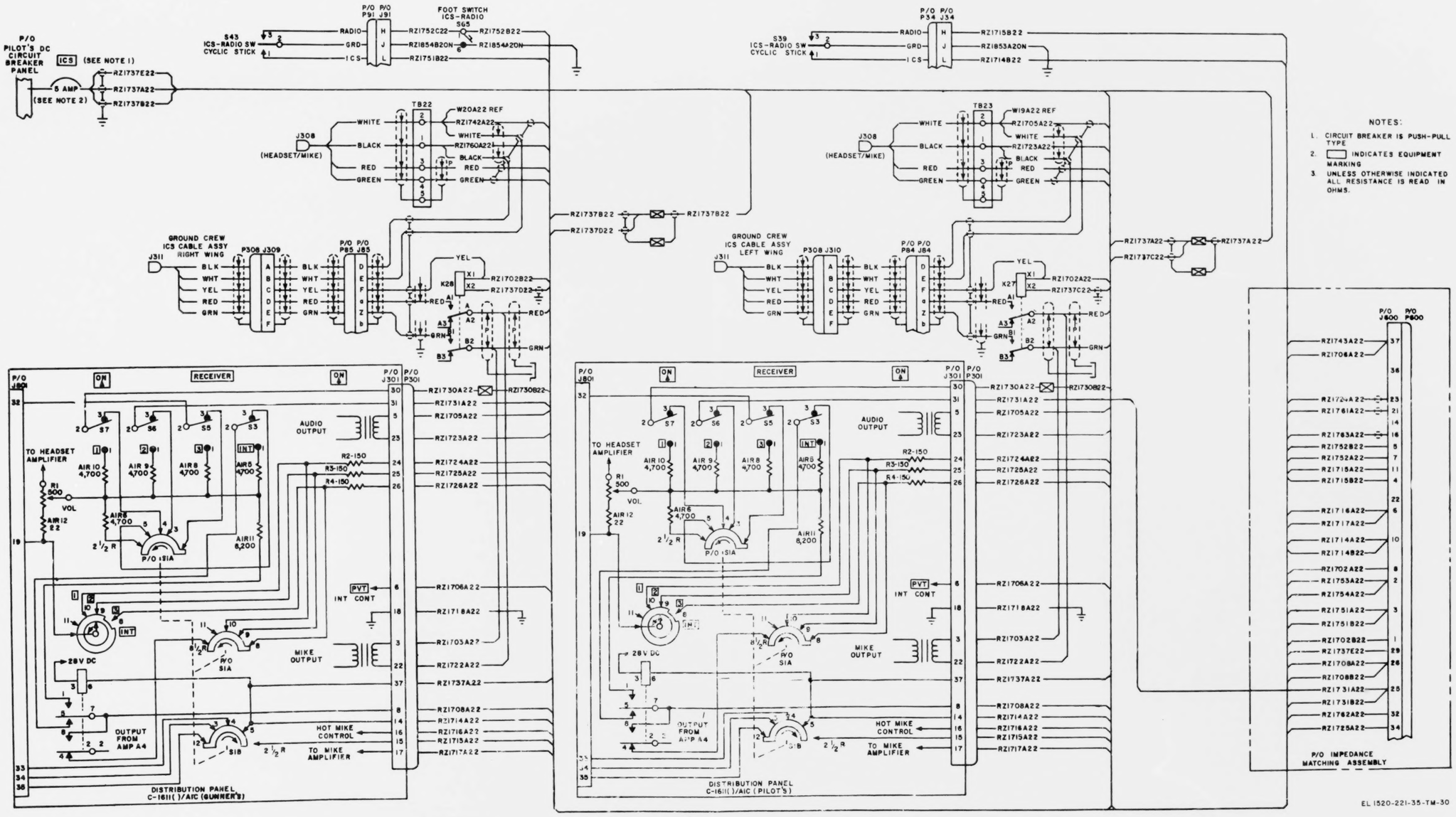


Figure FO–2. Interphone facility schematic, configurations A and B.

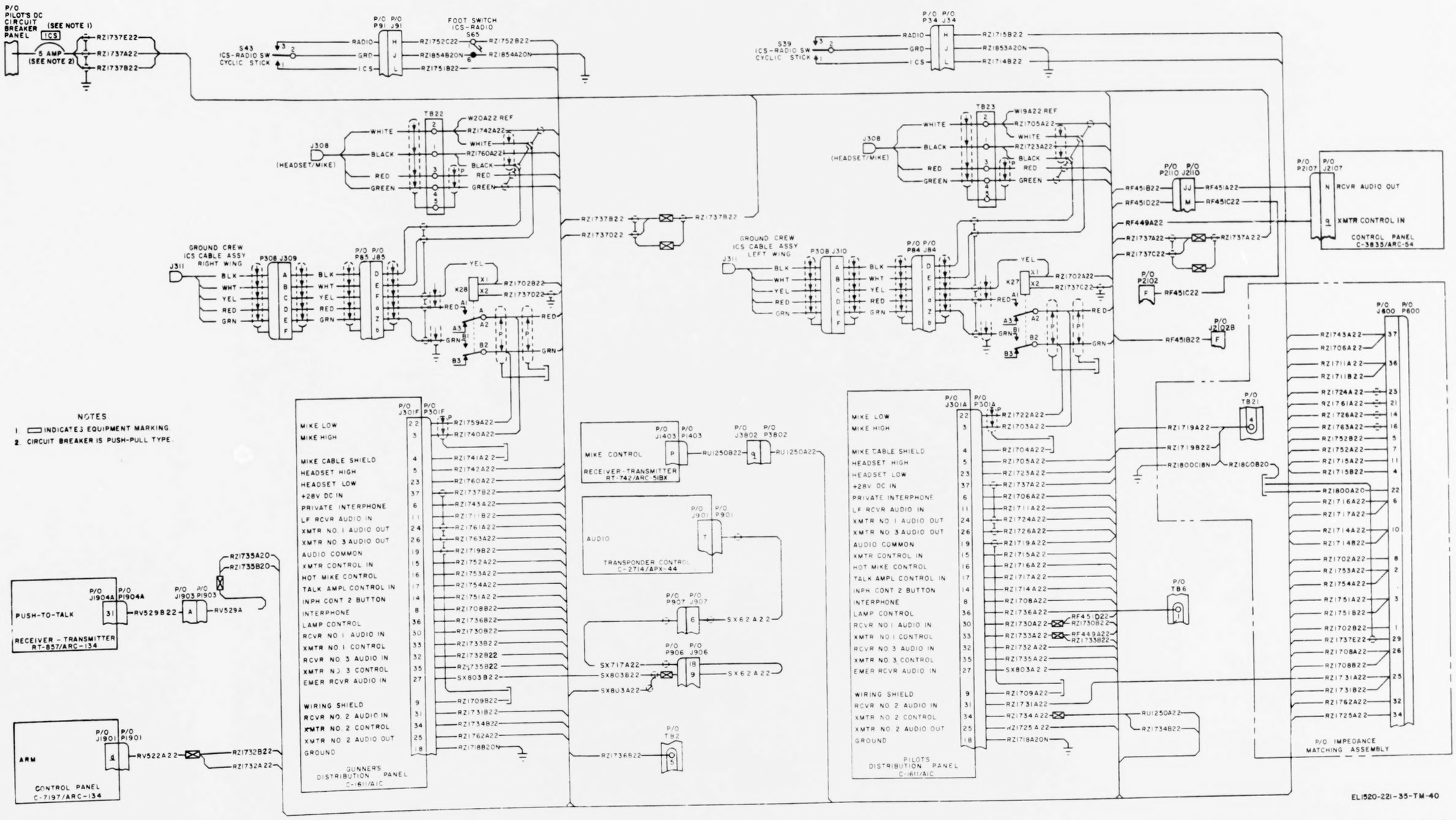


Figure FO-3. Interphone facility schematic, configuration C.

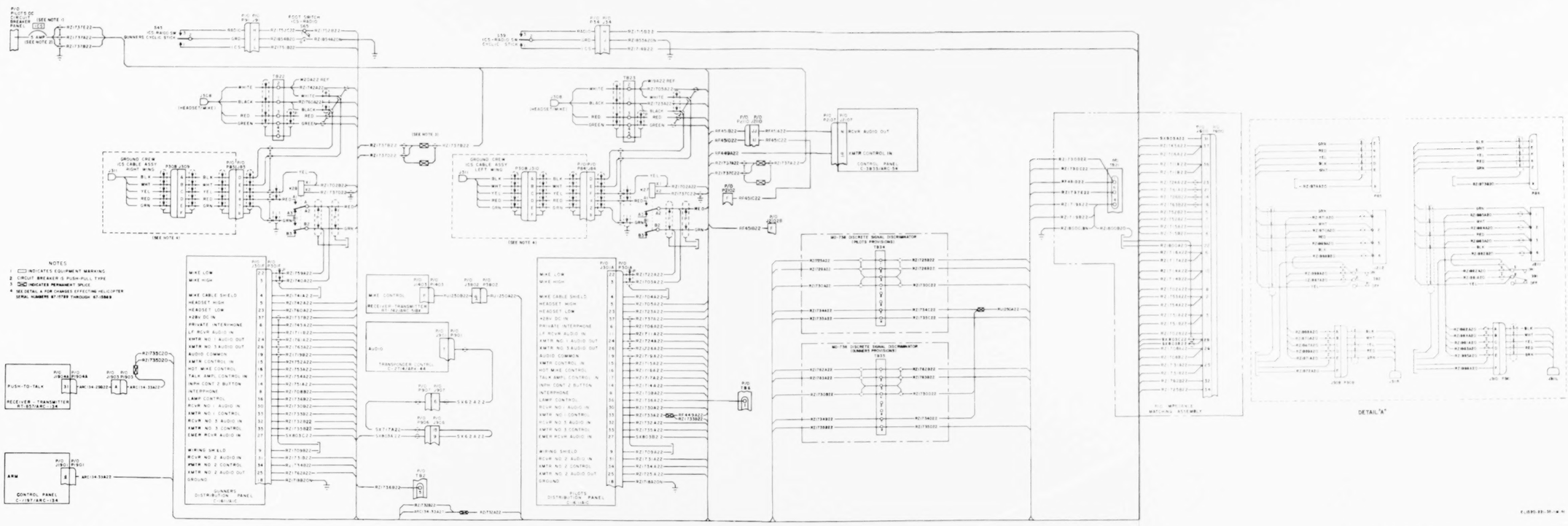
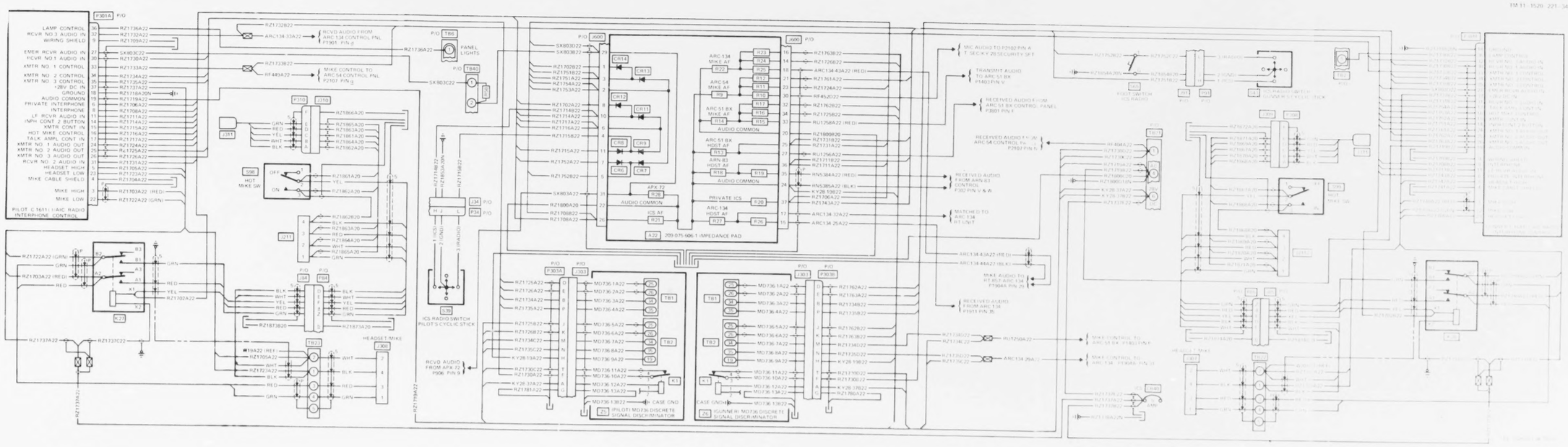


Figure FO-4. Interphone facility schematic, configuration D.


P301A
LAMP CONTROL
RCVR NO.3 AUDIO IN
WIRING SHIELD
EMER RCVR AUDIO IN
RCVR NO1 AUDIO IN
XMTR NO. 1 CONTROL
XMTR NO. 2 CONTROL
XMTR NO. 3 CONTROL
+28V DC IN
GROUND
AUDIO COMMON
PRIVATE INTERPHONE
INTERPHONE
LF RCVR AUDIO IN
INPH CONT 2 BUTTON
XMTR CONT IN
HOT MIKE CONTROL
TALK AMPL CONT IN
XMTR NO. 1 AUDIO OUT
XMTR NO. 2 AUDIO OUT
XMTR NO. 3 AUDIO OUT
RCVR NO. 2 AUDIO IN
HEADSET HIGH
HEADSET LOW
MIKE CABLE SHIELD
MIKE HIGH
MIKE LOW
PILOT C-1611(*)/AIC RADIO INTERPHONE CONTROL
RCVD AUDIO FROM ARC134 CONTROL PNL P1901 PIN g
MIKE CONTROL TO ARC54 CONTROL PNL P2107 PIN g
PANEL LIGHTS
J310
J311
S98
HOT MIKE SW
OFF
ON
J11
J34
P34
J4
P4
J1
P1
K1
K2
K3
K4
K5
K6
K7
K8
K9
K10
K11
K12
K13
K14
K15
K16
K17
K18
K19
K20
K21
K22
209-075-606-1 IMPEDANCE PAD
J600
APX J2
AUDIO COMMON
ICS AF
PRIVATE ICS
ARC 134 MIKE AF
ARC 54 MIKE AF
ARC 51 BX MIKE AF
ARC 51 BX HOST AF
ARN 83 HOST AF
ARC 134 HOST AF
ARC 134 25A22
ARC 134 32A22
ARC 134 43A22 (RED)
ARC 134 44A22 (BLK)
MIC AUDIO TO P2102 PIN A T. SEC KY 28 SECURITY SET
TRANSMIT AUDIO TO ARC 51 BX P1403 PIN V
RECEIVED AUDIO FROM ARC 51 BX CONTROL PANEL P1801 PIN K
RECEIVED AUDIO FROM ARC 54 CONTROL PL P2107 PIN S
RECEIVED AUDIO FROM ARN 83 CONTROL P1901 PIN V & W
MATCHED TO ARC 134 RT UNIT
MIKE AUDIO TO RT 857 ARC 134 P1904A PIN 25
RECEIVED AUDIO FROM ARC 134 P1911 PIN 35
FOOT SWITCH ICS RADIO
ICS RADIO SWITCH POWER SWITCH CHOKE
HOT MIKE SW
HEADSET MIKE
J306
T82
T83
T84
T86
T840
T81
ICS RADIO SWITCH PILOTS CYCLIC STICK
RCVD AUDIO FROM APX 72 P506 PIN 9
P303A
P303
P303B
J303
MD736-1A22
MD736-2A22
MD736-3A22
MD736-4A22
MD736-5A22
MD736-6A22
MD736-7A22
MD736-8A22
MD736-9A22
MD736-10A22
MD736-11A22
MD736-12A22
MD736-13A22
MD736-1B22
CASE GND
Z5 (PILOT) MD736 DISCRETE SIGNAL DISCRIMINATOR
Z6 (GUNNER) MD736 DISCRETE SIGNAL DISCRIMINATOR
RZ1722A22 (GRN)
RZ1703A22 (RED)
RZ1737A22
RZ1737C22
RZ1737A22

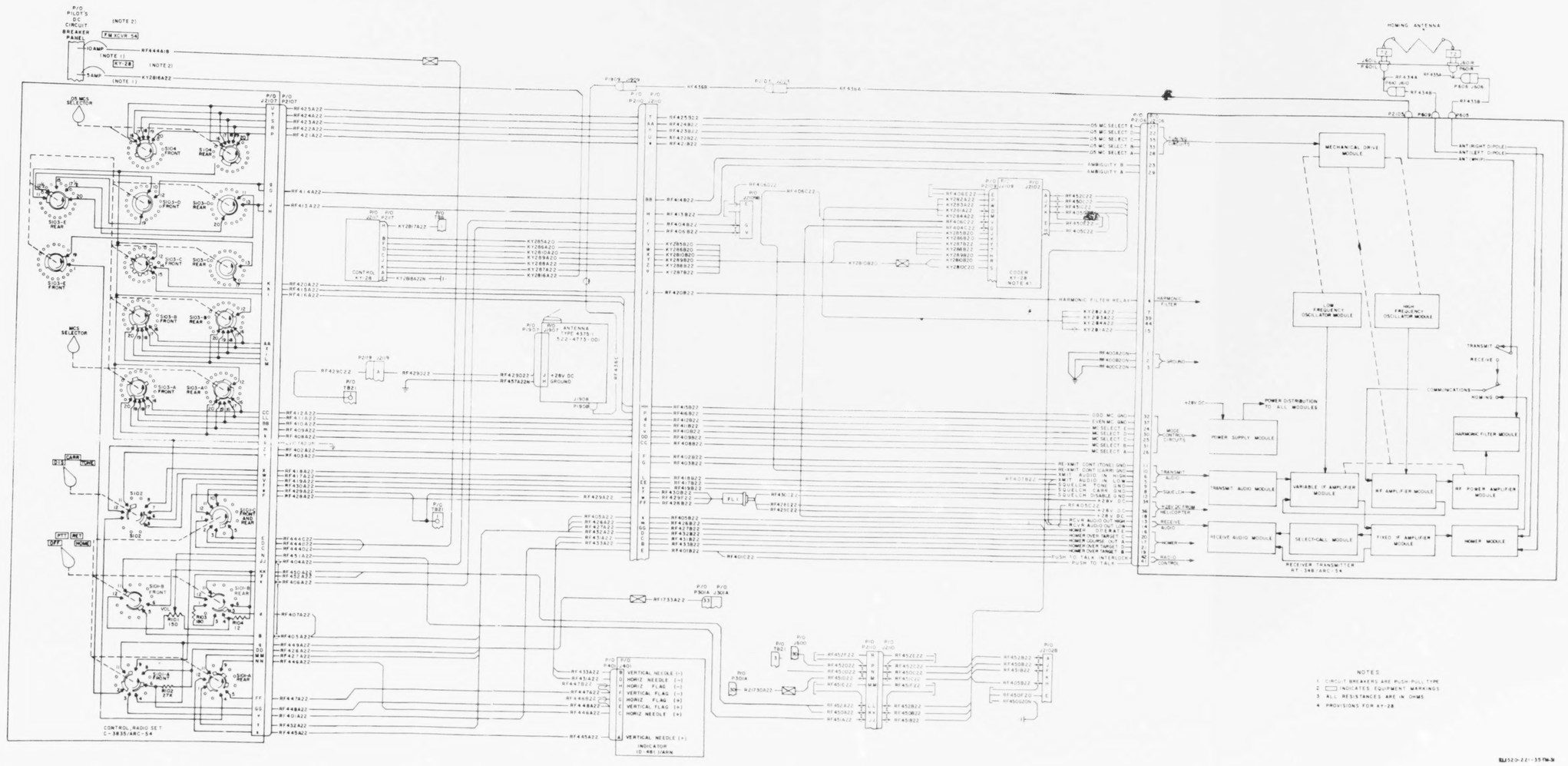
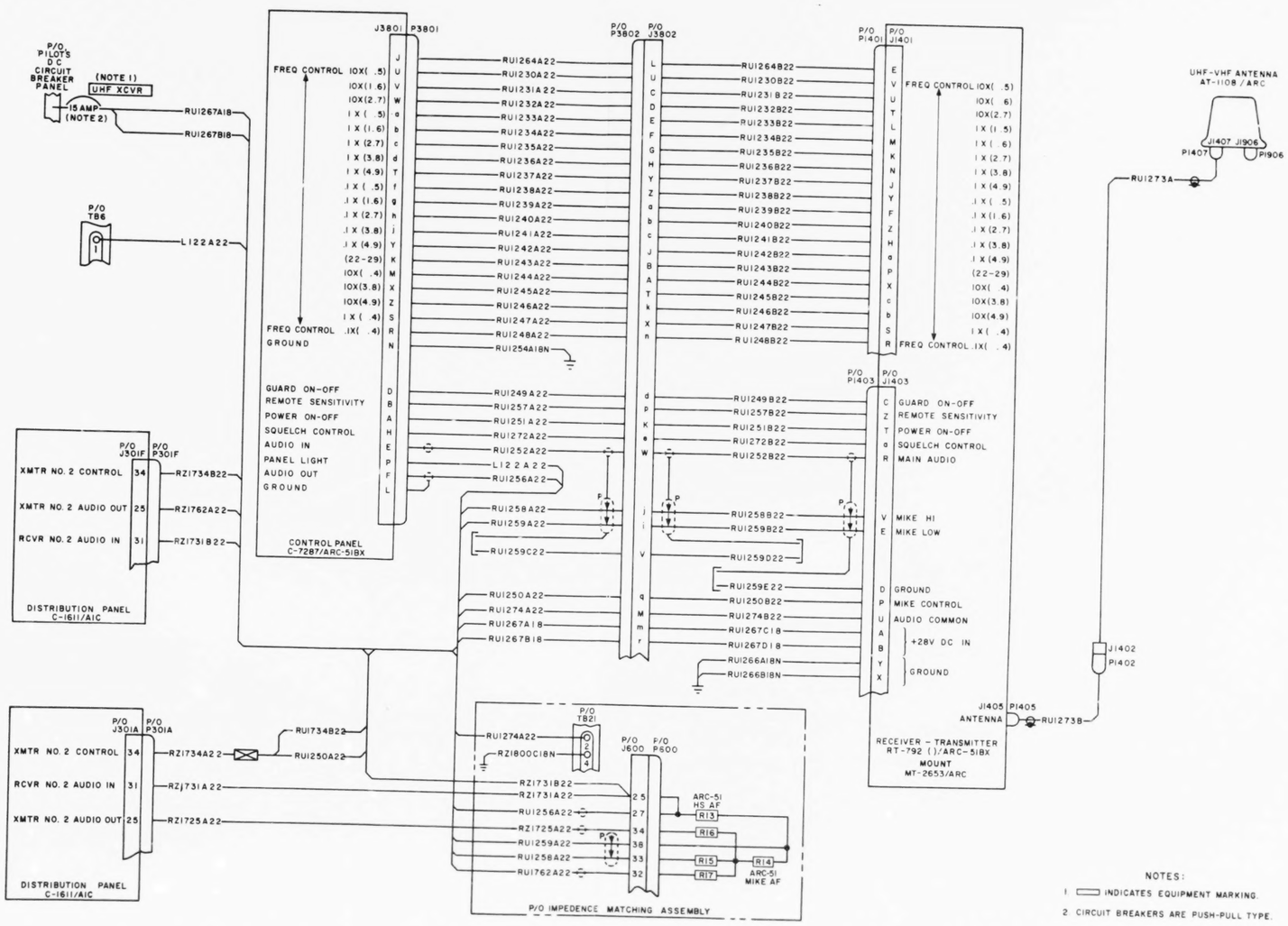


Figure FO–5. Fm liaison facility schematic.



NOTES:

1. ▭ INDICATES EQUIPMENT MARKING.
2. CIRCUIT BREAKERS ARE PUSH-PULL TYPE.

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Figure FO-6. Uhf command facility schematic.

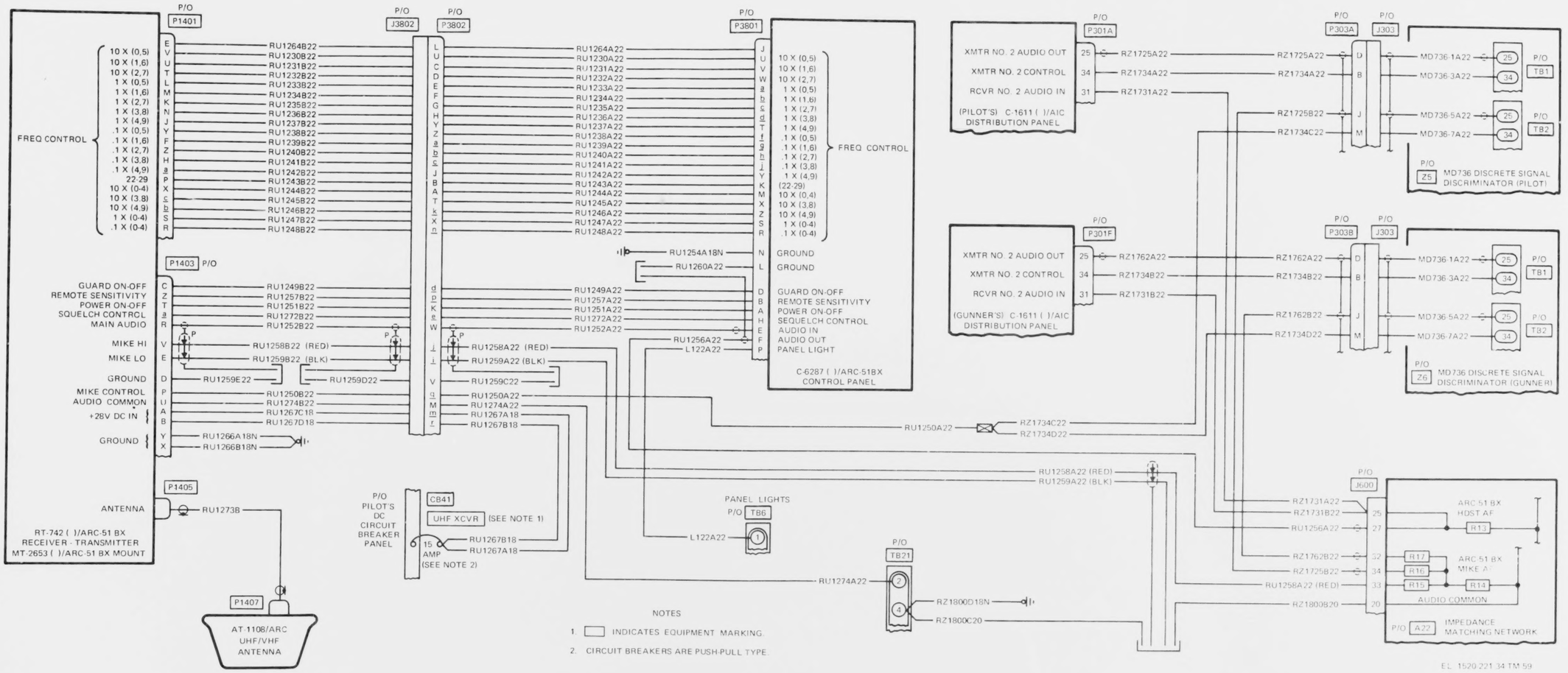


Figure FO-6.1. UHF command facility, schematic diagram, configuration. Change 1

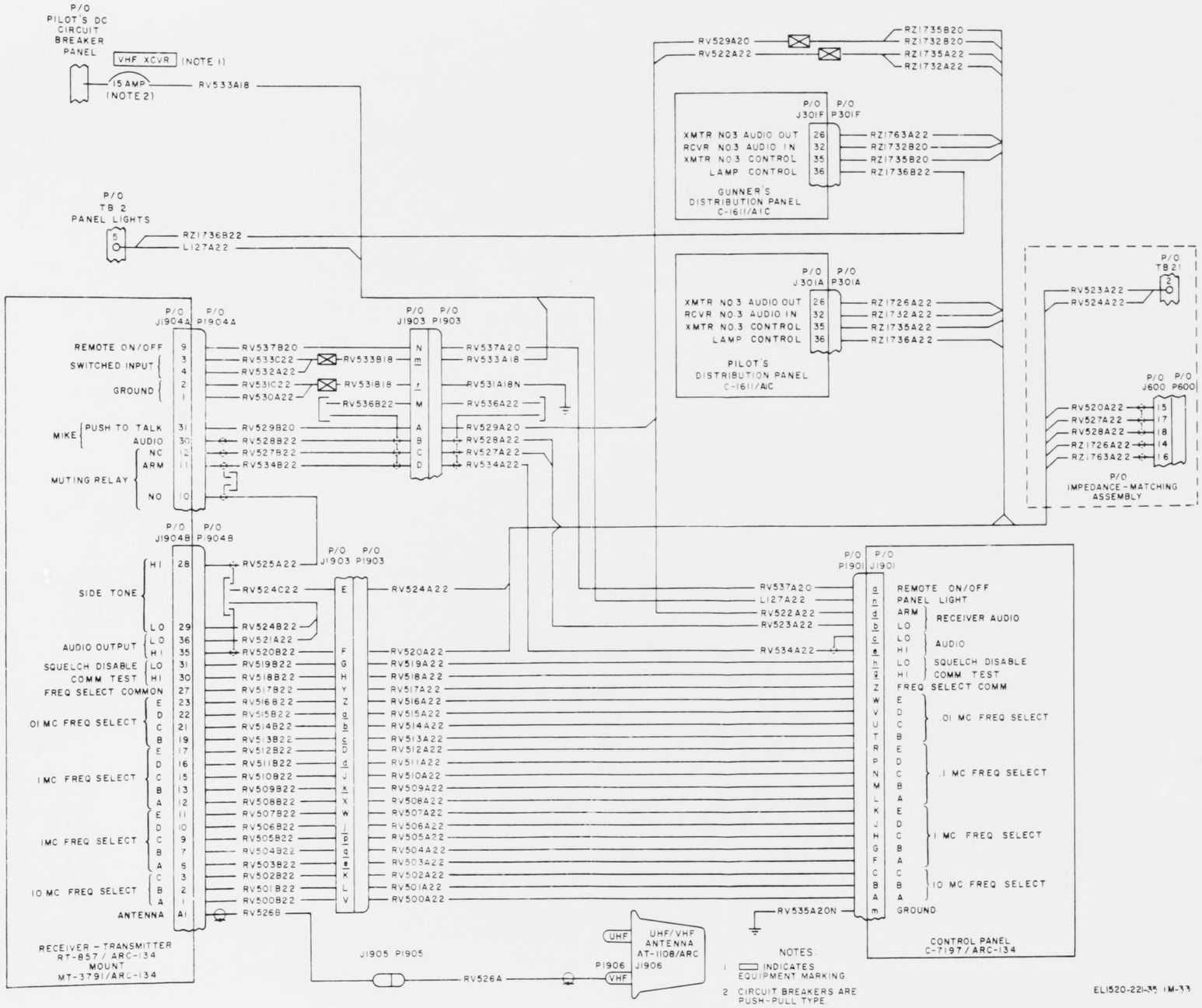


Figure FO–7. Vhf command facility schematic, configurations A, B, and C.

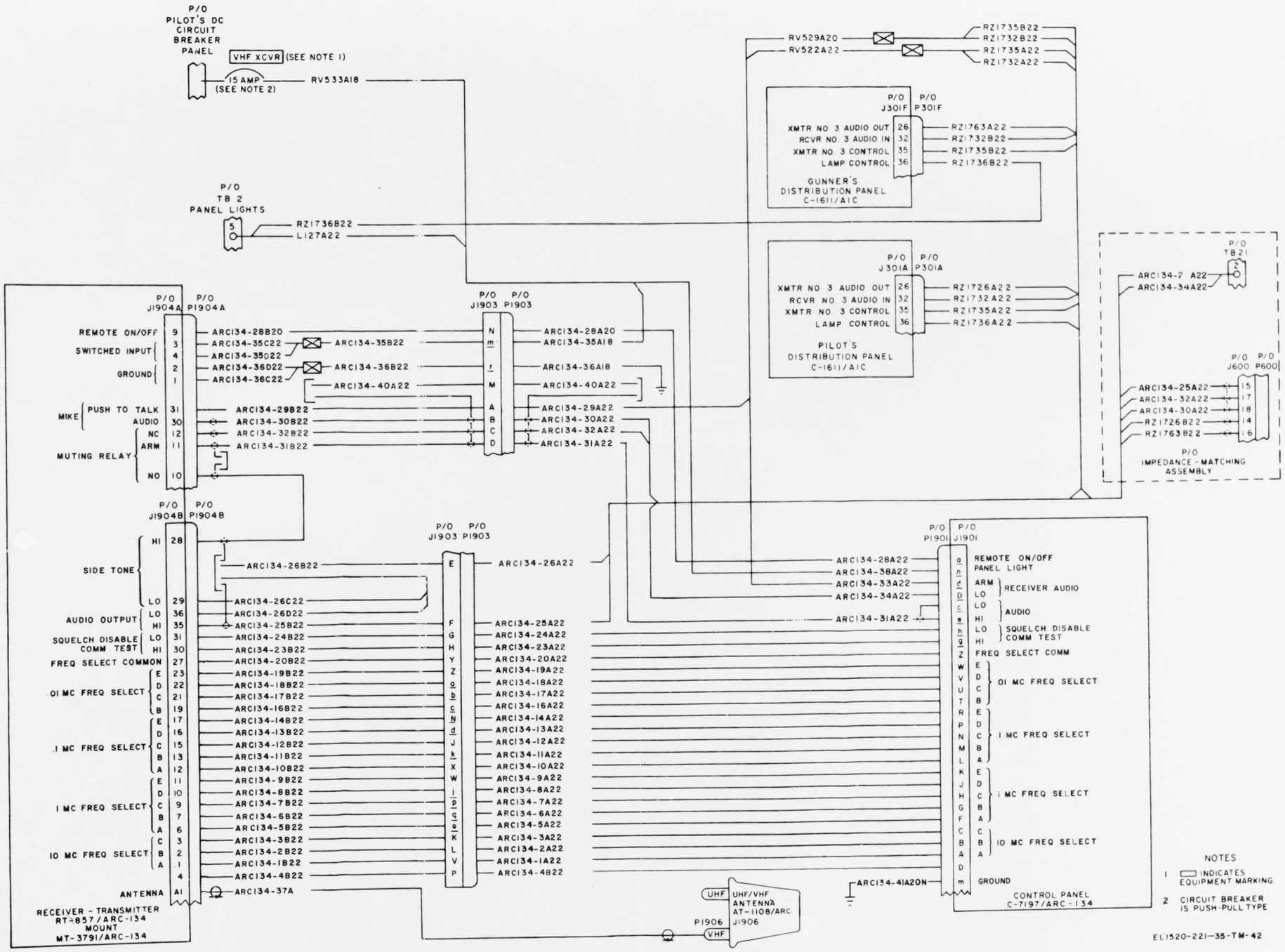


Figure FO–8. Vhf command facility schematic, configuration D.

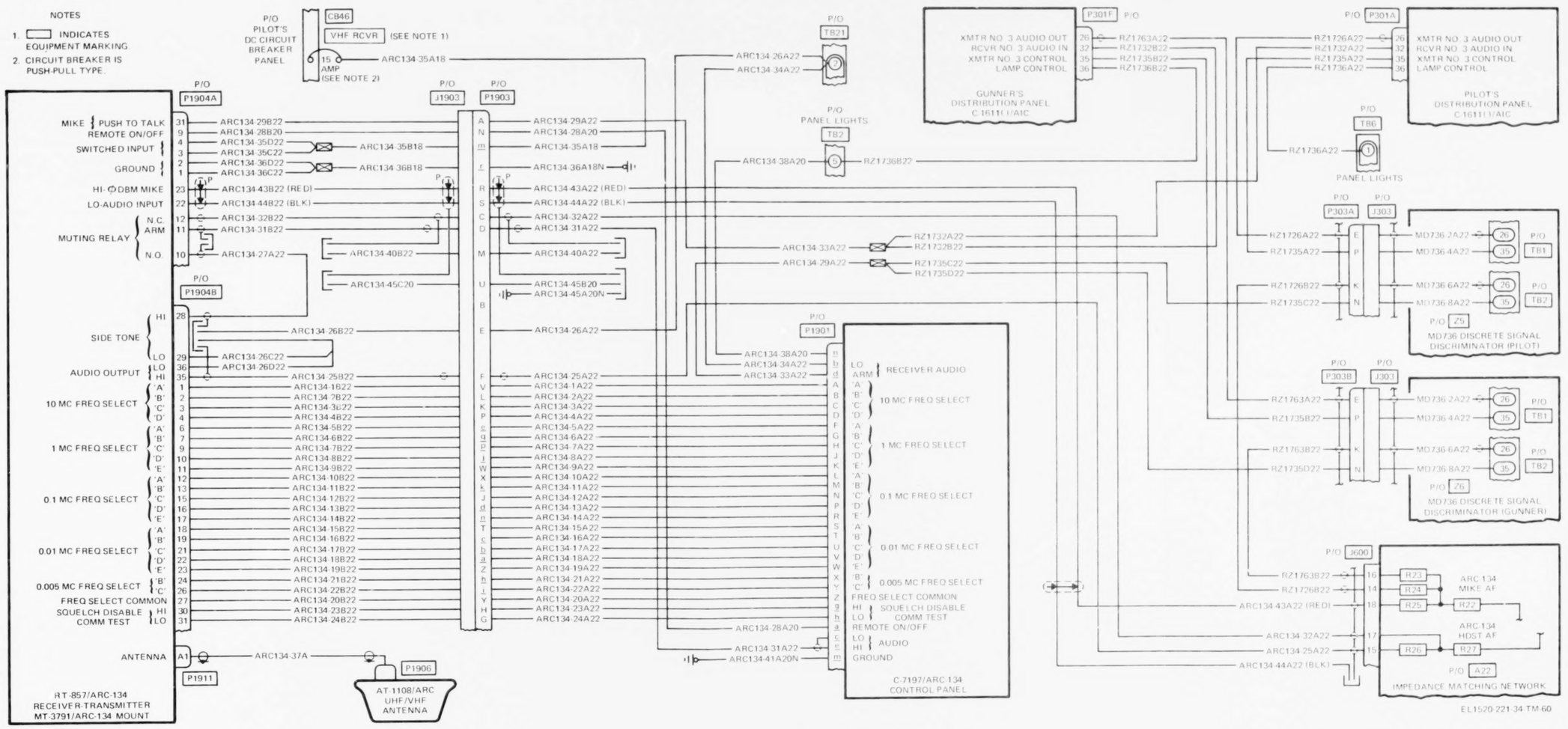


Figure FO-8.1. VHF command facility, schematic diagram, configuration.

Change 1

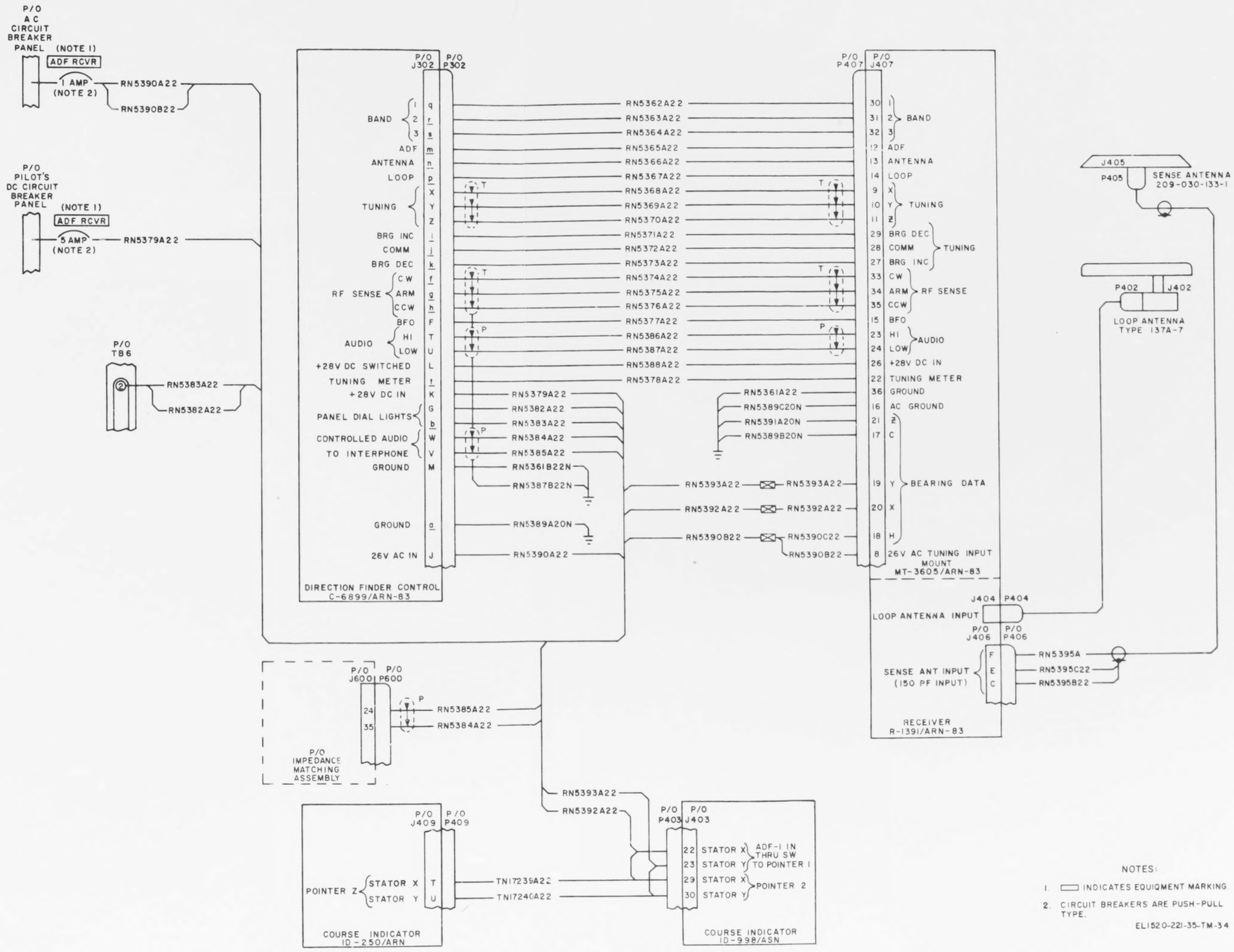


Figure FO–9. Adf navigation facility schematic.

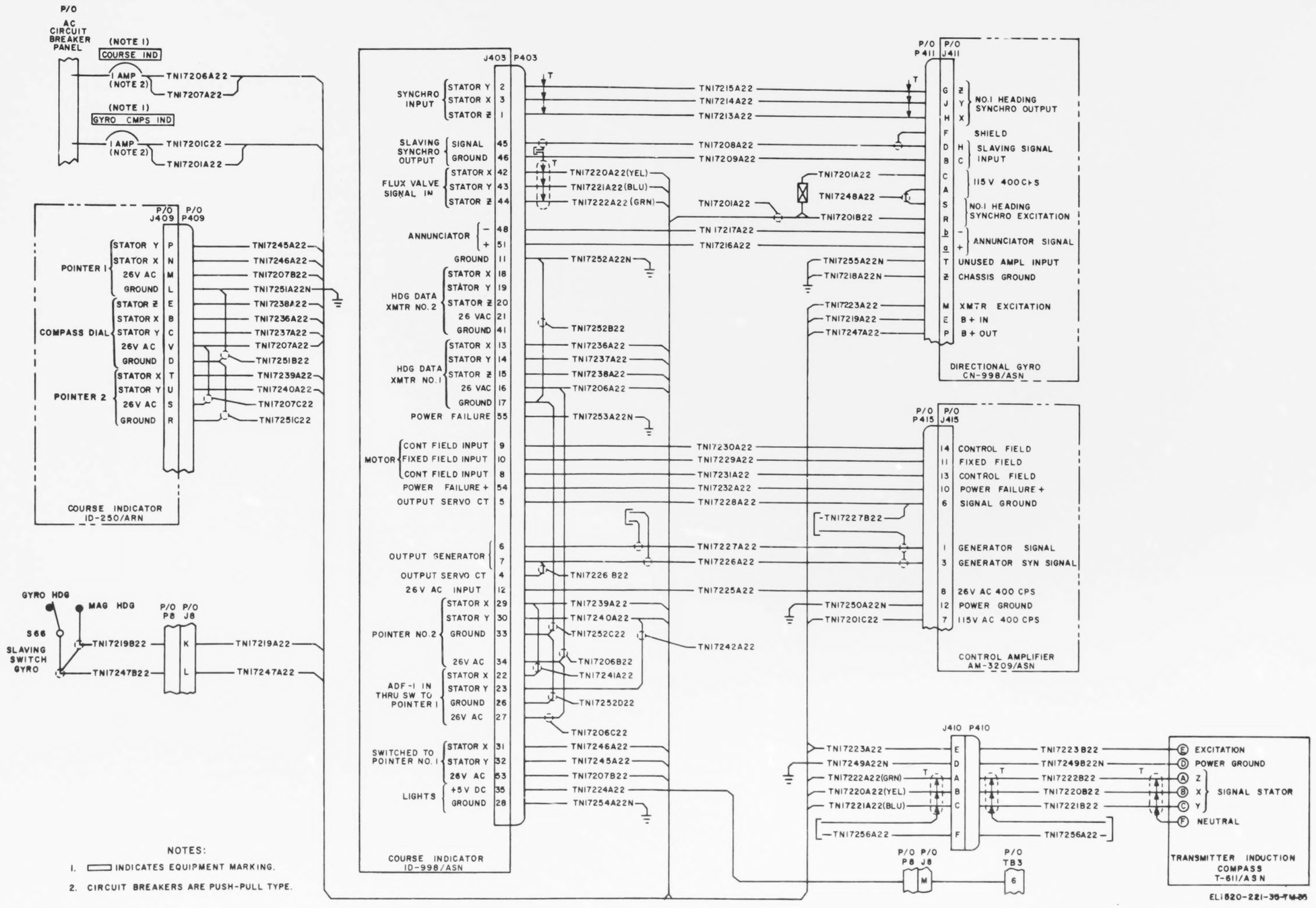
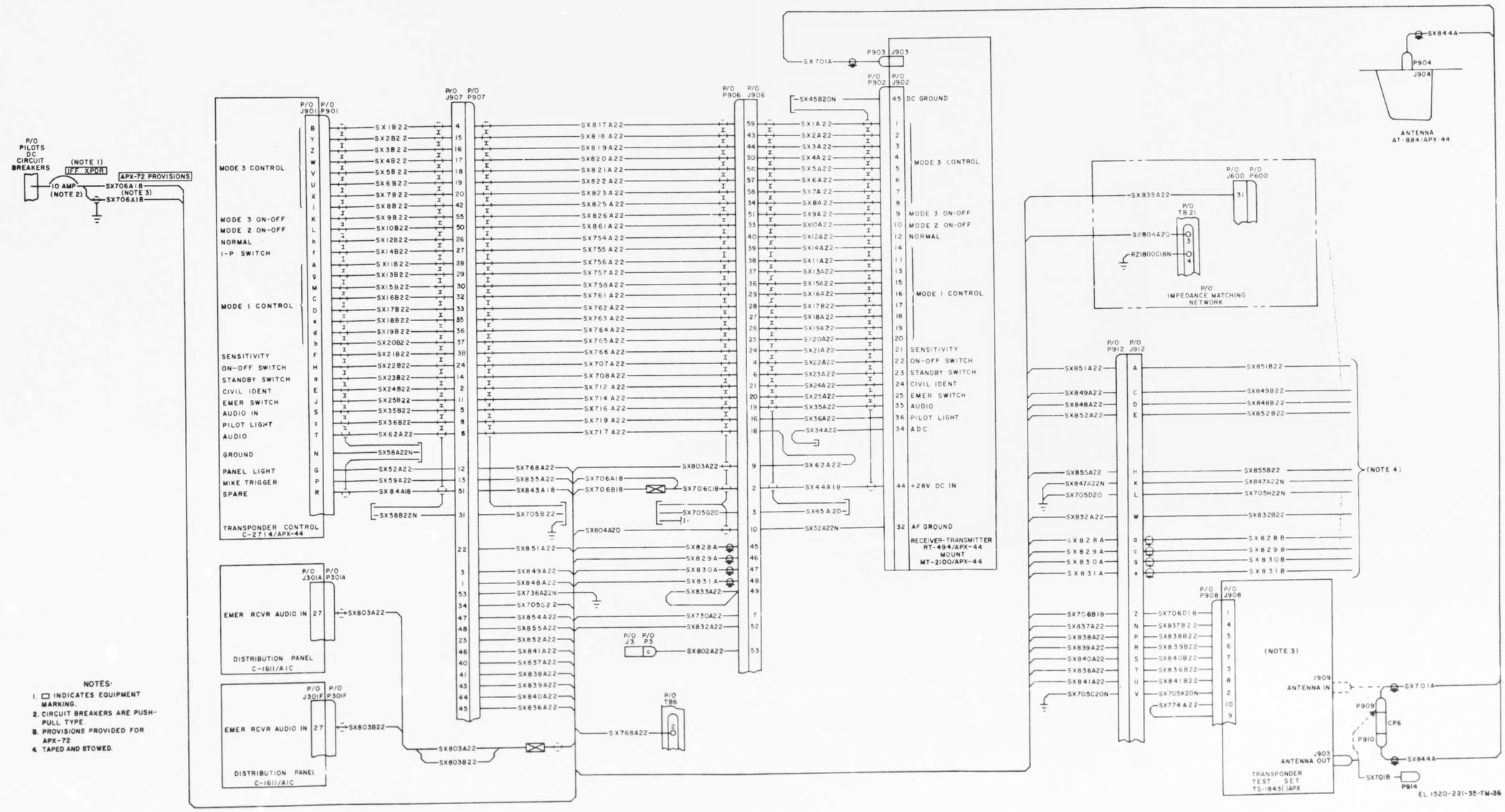
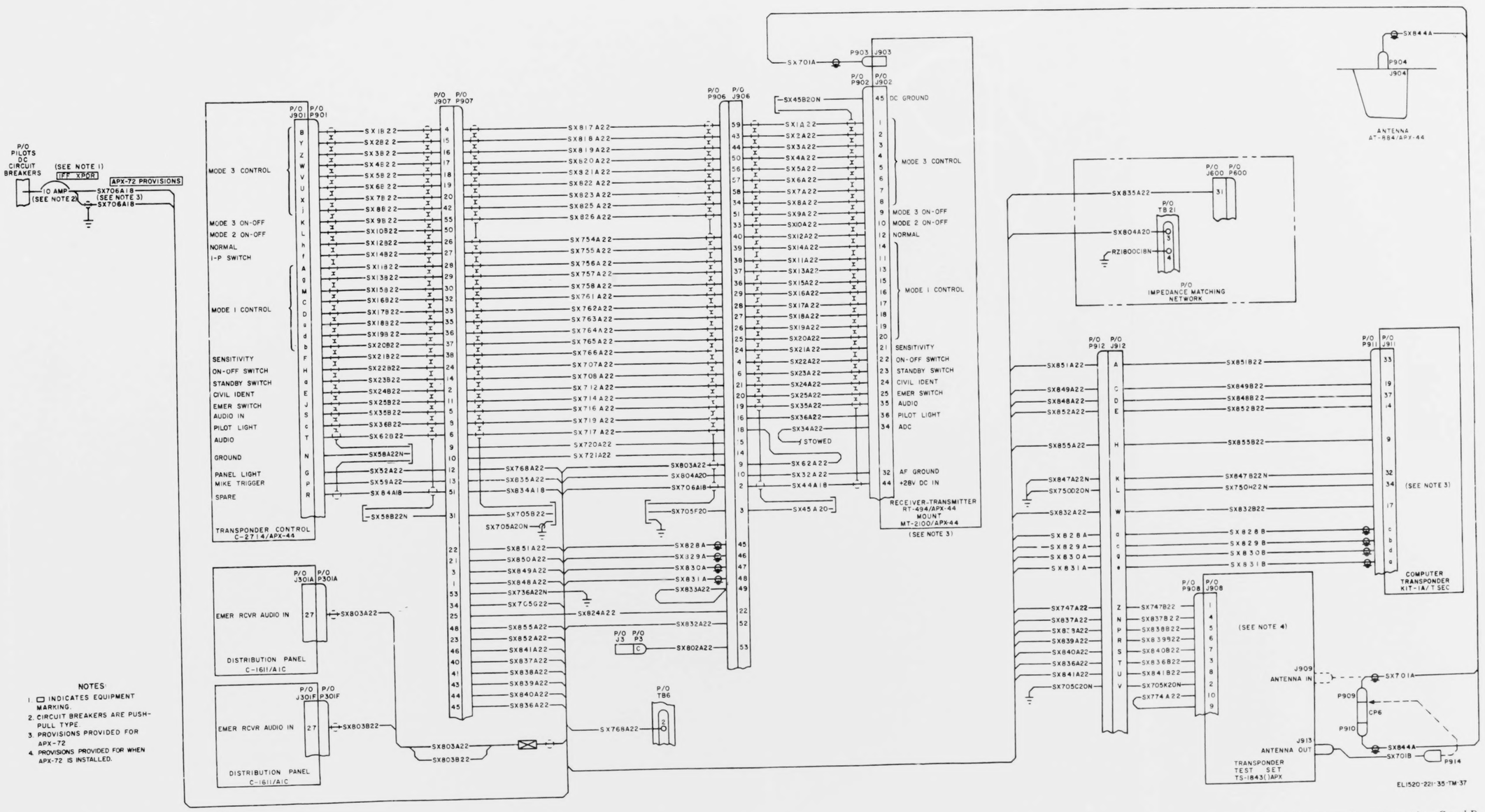


Figure FO–10. Gyromagnetic compass system schematic.



NOTES:
1. ▭ INDICATES EQUIPMENT MARKING.
2. CIRCUIT BREAKERS ARE PUSH-PULL TYPE.
3. PROVISIONS PROVIDED FOR APX-72
4. TAPED AND STOWED.

Figure FO–11. Transponder facility schematic, configurations A and B.



NOTES:

1. ☐ INDICATES EQUIPMENT MARKING.
2. CIRCUIT BREAKERS ARE PUSH-PULL TYPE.
3. PROVISIONS PROVIDED FOR APX-72.
4. PROVISIONS PROVIDED FOR WHEN APX-72 IS INSTALLED.

Figure FO-12. Transponder facility schematic, configurations C and D.

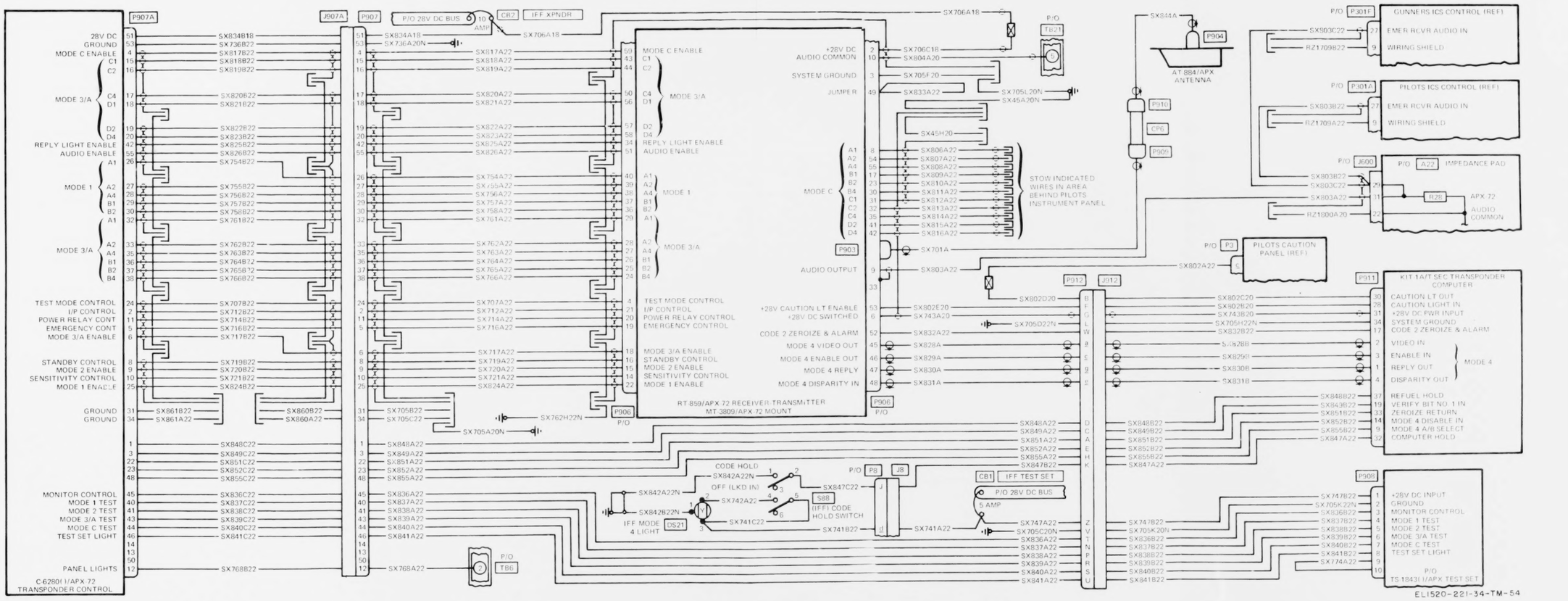


Figure FO-12-1. Transponder facility, schematic diagram, configuration A, B, C, and D (when MWO 55-1520-221-80T3 is accomplished).

Change 1

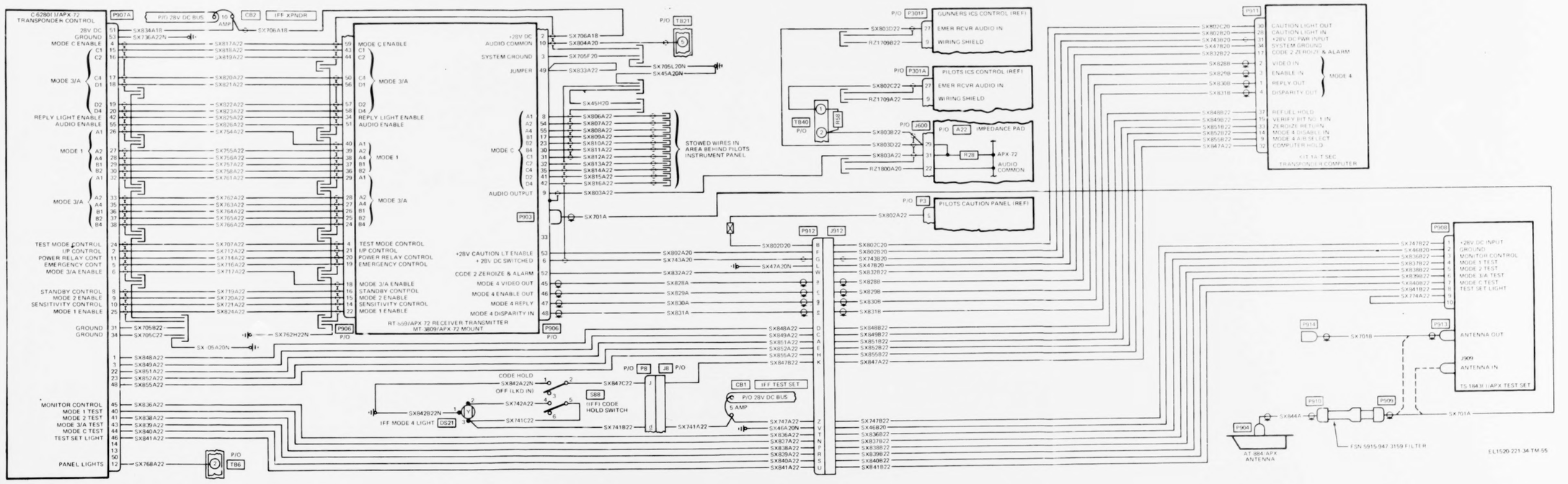


Figure 11-22. Transponder facility, schematic diagram, configuration E.

Change 1

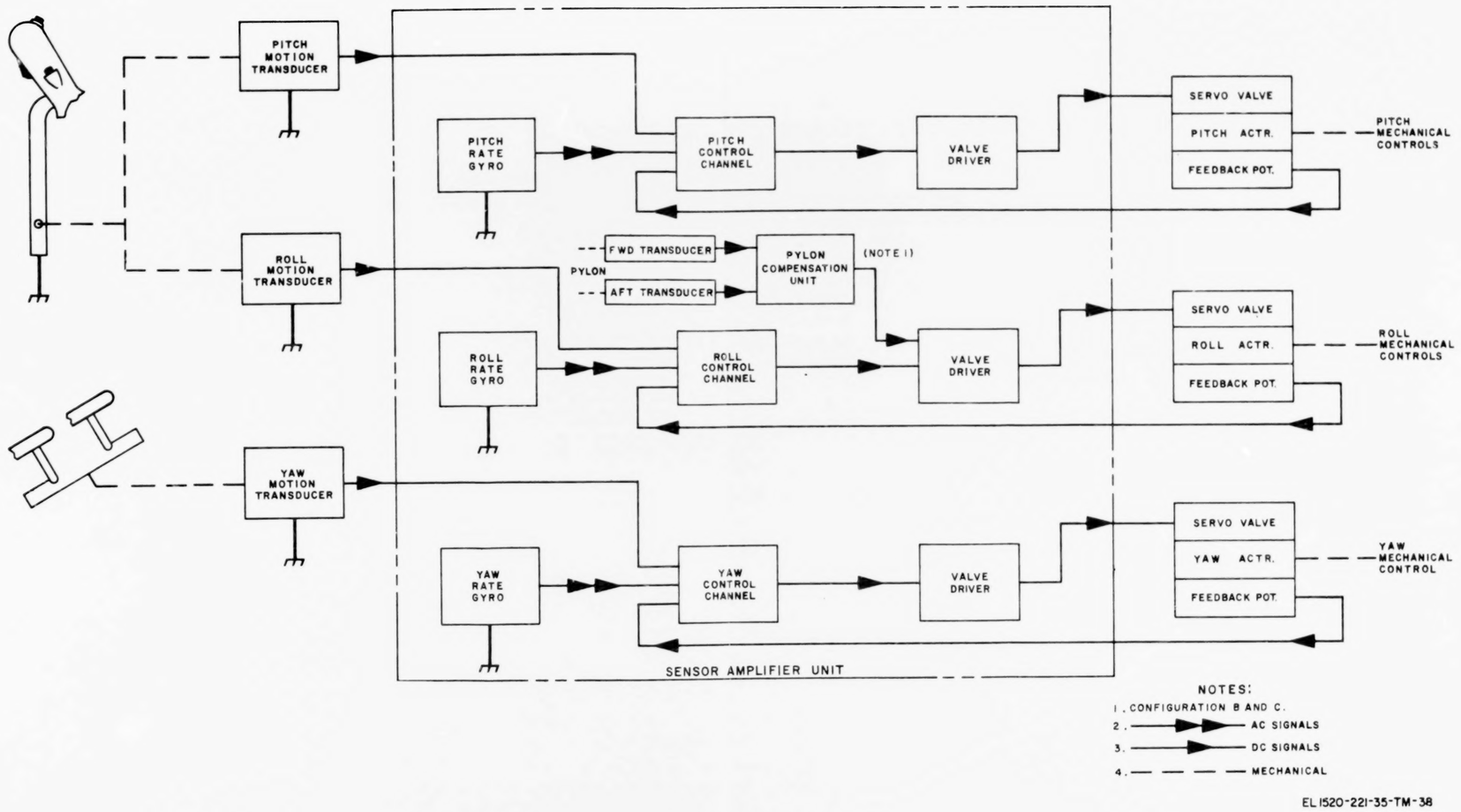


Figure FO–13. SCAS block diagram.

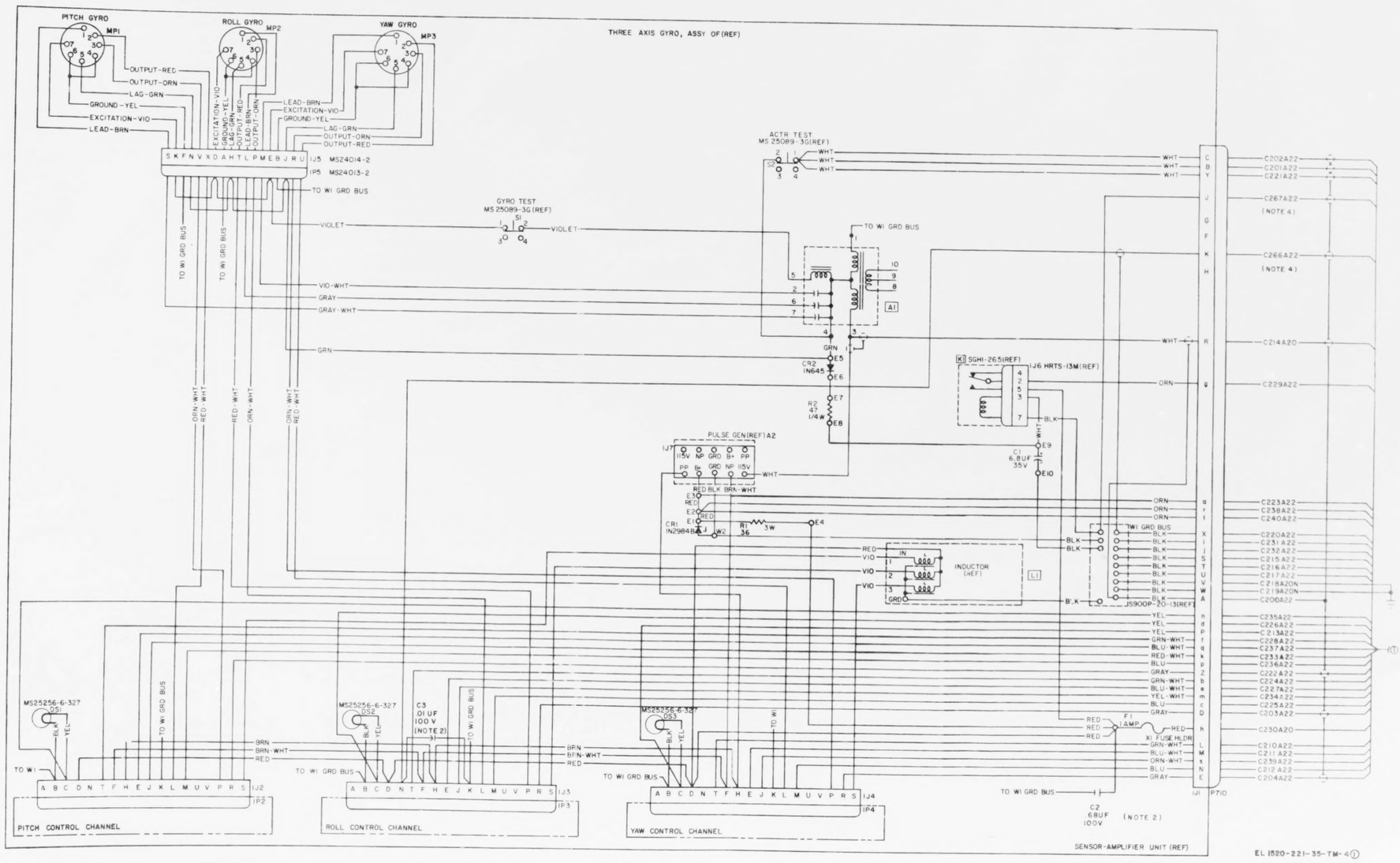


Figure FO-14①. SCAS schematic diagram (part 1 of 2).

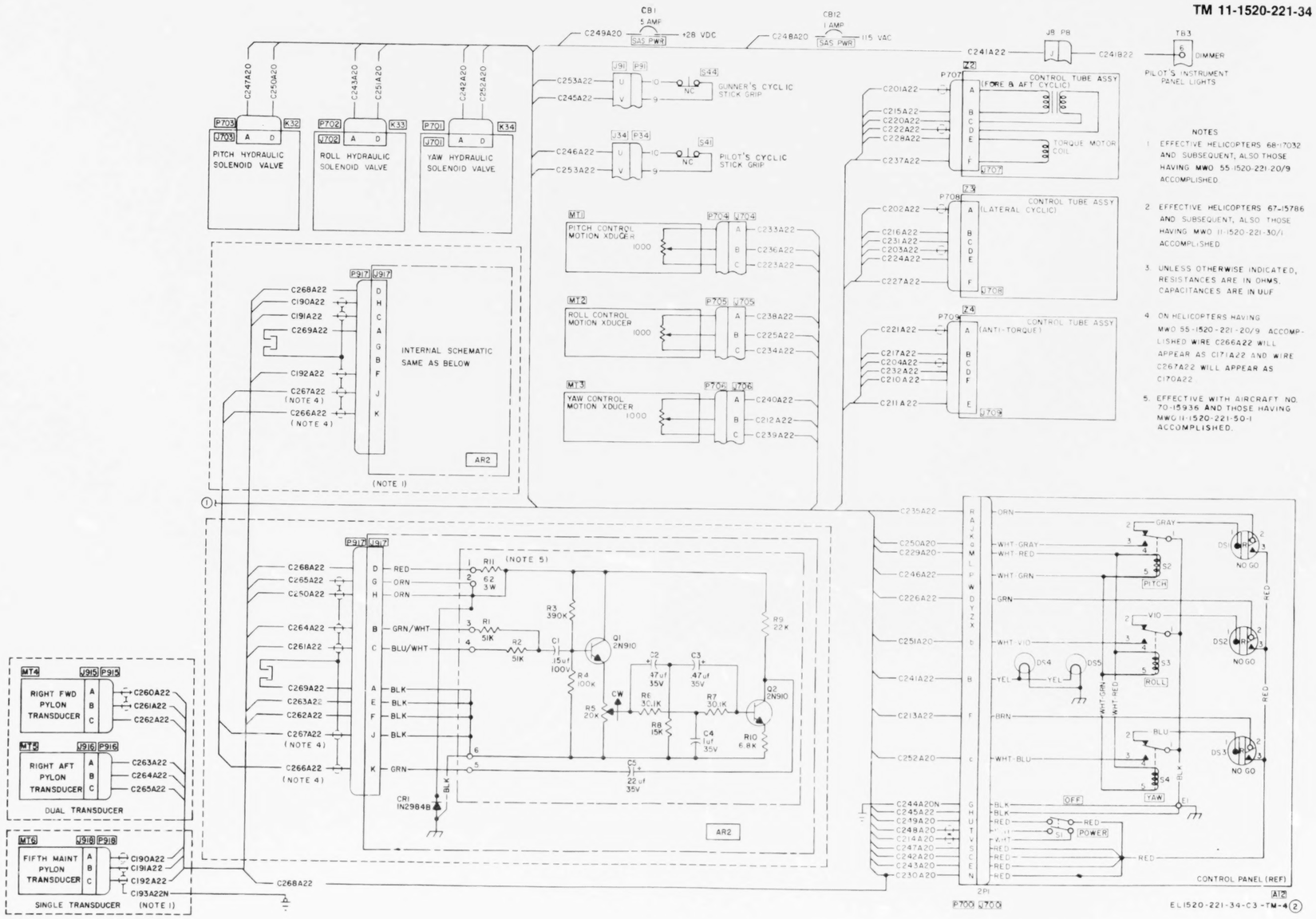


Figure FO-14 2. SCAS schematic diagram (part 2 of 2).

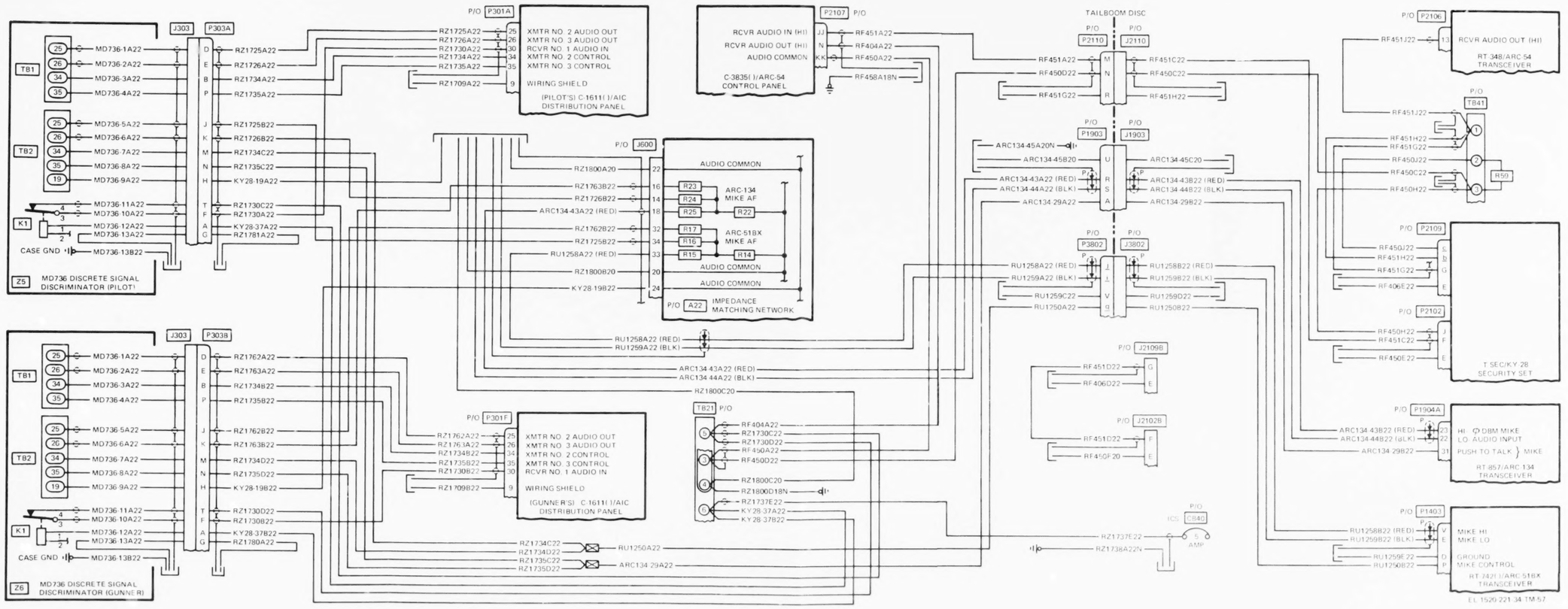


Figure FO-15. KY-28 voice security system provisions, schematic diagram, configuration C, per MWO 55-1520-221-30/06. **Change 1**

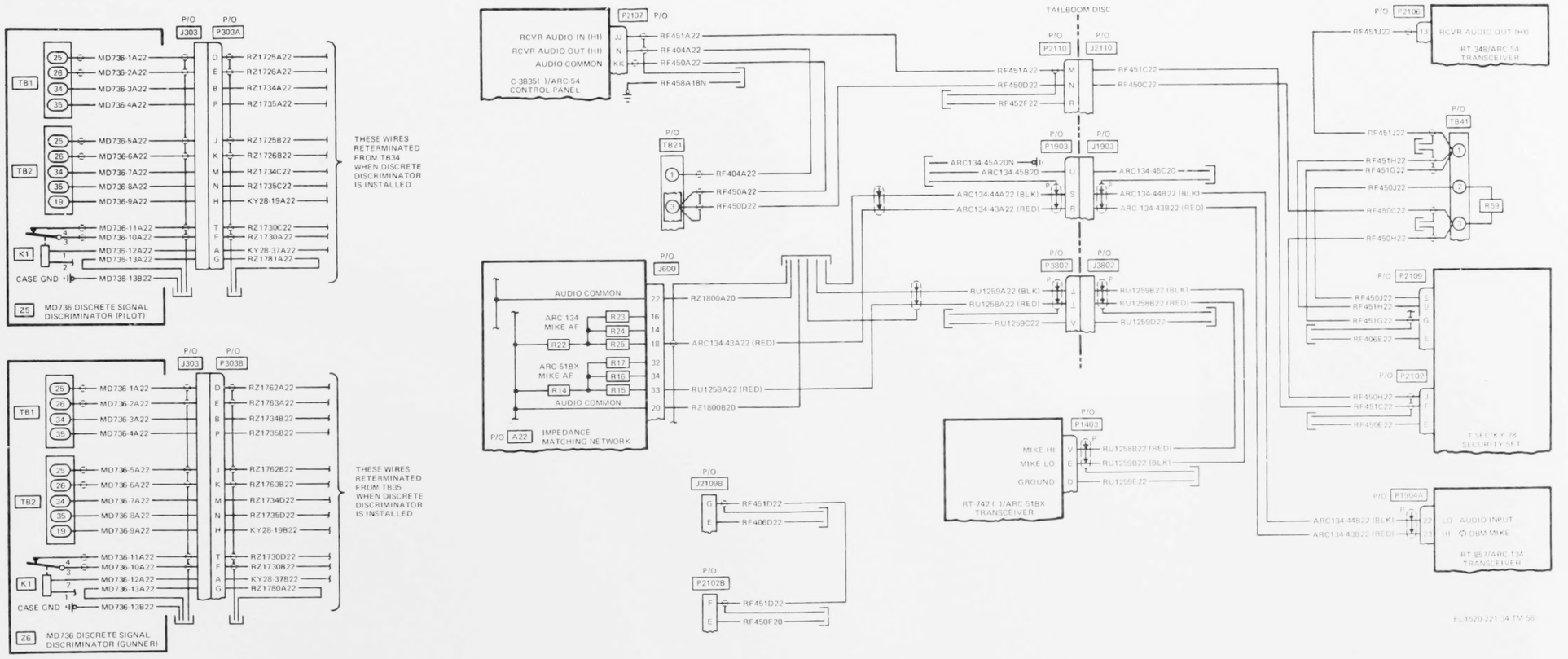
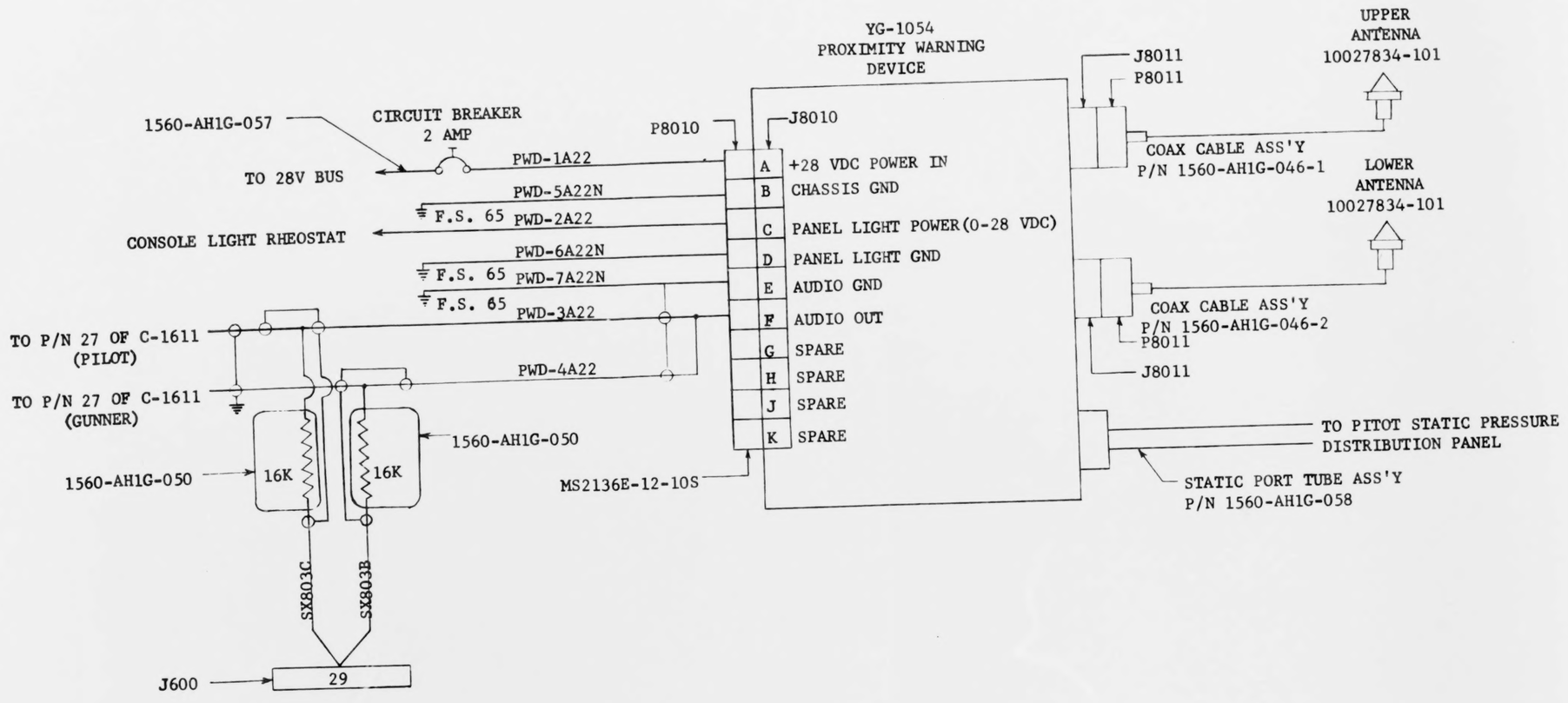


Figure FO-1a. KY-28 wire wrap provisions, schematic diagram, configuration II, per MWO 55-1520-221-P/37. Change 1



EL1520-221-35-C2-TM-40

Figure FO-17. Proximity warning system.